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CSE 330 Data Structures

Winter 2018

HW 2 – problem 2.8

* **Source Code**

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\* Eric Blasko

\* test1.cpp

\* 02/12/2018

\* This program takes an array and randomly fills it with random numbers. The rand()

\* function is used to generate the random numbers. If numbers have been used already

\* in array, a new number that has not been used is generated until array is full

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#include <iostream>

using namespace std;

//Main function that uses a while loop to insert the random numbers, with a for loop

//the checks if the numbers been used before

int main()

{

int n = 0;

int i = 0 ;

int temp = 0;

bool found = false;

srand(time(0));

cout << "Enter size: ";

cin >> n;

int \*arr = new int[n];

while(i < n)

{

temp = rand()%n;

found = false;

for(int j = 0; j < i; j++)

{

if(arr[j] == temp)

{

found = true;

break;

}

}

if(found == false)

{

arr[i] = temp;

i++;

}

}

for(int i = 0; i < n; i++)

cout << arr[i] << " ";

cout << endl;

delete [] arr;

}

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\* Eric Blasko

\* test2.cpp

\* 02/12/2018

\* This program takes an array and fills it with random numbers based on size of array.

\* A second array is used to check if the generated number has been used, if so, a new

\* number is generated. The process if filled until array is full

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#include <iostream>

using namespace std;

//Main function that loops till array is filled with random numbers. Second array is

//of boolean type which becomes true after that number has been used

int main()

{

int n = 0;

int i = 0;

int temp = 0;

srand(time(0));

cout << "Enter size: ";

cin >> n;

int \*arr = new int[n];

bool \*used = new bool[n]{false};

while(i < n)

{

temp = rand()%n;

if(used[temp] == false)

{

arr[i] = temp;

used[temp] = true;

i++;

}

}

for(int i = 0; i < n; i++)

cout << arr[i] << " ";

cout << endl;

delete [] arr;

delete [] used;

}

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* Eric Blasko

\* test3.cpp

\* 02/12/2018

\* This program fills and array with non repeating number, then randomly swapped to

\* create a random array of numbers of size N.

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#include <iostream>

using namespace std;

//Main function which fills an array of size N, then randomly swaps numbers around

int main()

{

int n;

srand(time(0));

cout << "Enter size: ";

cin >> n;

int \*arr = new int[n];

for(int i = 0; i < n; i++)

arr[i] = i;

for(int i = 0; i < n; i++)

swap(arr[i], arr[rand()%n]);

for(int i = 0; i < n; i++)

cout << arr[i] << " ";

cout << endl;

delete [] arr;

}

1. **Sample Runs**

Script started on 2020-02-08 16:23:12-0800

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ g++- ^H^[[K^H^[[K -c test1.cpp^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ g++ test1 ^H^[[K.cpp^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ ./a.out^M

Enter size: 10^M

5 9 1 4 2 6 0 8 3 7 ^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ ./a.out^M

Enter size: 15^M

0 4 10 11 1 6 14 12 3 13 8 5 7 9 2 ^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ ./a.out^M

Enter size: 20^M

16 12 13 18 1 17 9 2 4 15 5 7 6 11 0 14 8 3 10 19 ^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ exit^M

Script done on 2018-02-08 16:23:45-0800

Script started on 2018-02-08 16:29:56-0800

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ g++ -c test2.cpp^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ g++ test2.cpp^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ a.^H^[[K^H^[[K./a.out^M

Enter size: 10^M

7 4 2 5 6 9 3 0 1 8 ^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ ./a.out^M

Enter size: 15^M

3 4 1 12 8 11 7 13 2 5 6 0 14 9 10 ^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ ./a.out^M

Enter size: 20^M

15 14 12 3 18 7 9 1 2 5 6 8 19 16 13 0 4 17 11 10 ^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ exit^M

Script done on 2018-02-08 16:30:28-0800

Script started on 2018-02-08 16:35:18-0800

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ g++ -c test3.cpp^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ g++ test3.cpp^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ ./a.out^M

Enter size: 10^M

1 4 0 6 7 9 5 2 3 8 ^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ ./a.out^M

Enter size: 15^M

1 3 2 14 6 4 11 7 8 0 12 9 5 13 10 ^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ ./a.out^M

Enter size: 20^M

6 8 0 17 2 10 7 16 4 9 3 14 13 1 12 5 15 18 19 11 ^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ exit^M

Script done on 2018-02-08 16:35:48-0800

1. **Big-Oh analysis**

Test1.cpp – This algorithm runs through a single array twice. One loop adds values to each index of the array and a second loop to check if that value has been used already. These two loops will always run making the algorithm O(n²), where n is the size of the array.

Test2.cpp – This algorithm runs through a single array one time. Even though there is a second array to verify if a number is used, it is considered a constant as no iteration is needed. Since there is only one loop and it is iterated n times, it is O(n), where n is the size of the array.

Test3.cpp – This algorithm runs through a single array in two separate loops. The first for loop fills the array, and the second swaps values while iterating only one time through the loop. This gives O(n+n) = O(2n), which simplifies to O(n) where n is the size of the array.

1. **Execution Times**

**Test1.cpp**

Script started on 2018-02-08 16:40:31-0800

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ time ./a.ut^H^[[K^H^[[Kout > output^M

250^M

^M

real 0m5.549s^M

user 0m0.001s^M

sys 0m0.004s^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output^M

250^M

^M

real 0m1.989s^M

user 0m0.003s^M

sys 0m0.001s^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output^M

250^M

^M

real 0m1.843s^M

user 0m0.002s^M

sys 0m0.002s^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output^M

250^M

^M

real 0m2.189s^M

user 0m0.002s^M

sys 0m0.002s^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output^M

250^M

^M

real 0m6.286s^M

user 0m0.002s^M

sys 0m0.002s^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output^M

250^M

^M

real 0m1.642s^M

user 0m0.003s^M

sys 0m0.001s^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output^M

250^M

^M

real 0m1.704s^M

user 0m0.003s^M

sys 0m0.001s^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output^M

250^M

^M

real 0m1.575s^M

user 0m0.002s^M

sys 0m0.002s^M

^[]0;005670557@csusb.edu@jb358-0:~/cse330/hw2^G[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output^M

250^M

^M

real 0m1.493s^M

user 0m0.002s^M

sys 0m0.001s^M

Script started on 2018-02-08 16:40:31-0800

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.ut[K[Kout > output

250

real 0m5.549s

user 0m0.001s

sys 0m0.004s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

500

real 0m8.566s

user 0m0.007s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

500

real 0m1.556s

user 0m0.006s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

500

real 0m1.366s

user 0m0.008s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output50[K[K

500

real 0m2.125s

user 0m0.005s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

500

real 0m1.676s

user 0m0.004s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

500

real 0m1.399s

user 0m0.006s

sys 0m0.000s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output500[K[K[K

500

real 0m1.520s

user 0m0.006s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

500

real 0m1.449s

user 0m0.009s

sys 0m0.000s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

500

real 0m1.465s

user 0m0.005s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

500

real 0m1.186s

user 0m0.008s

sys 0m0.000s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1000

real 0m2.150s

user 0m0.016s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1000

real 0m1.757s

user 0m0.016s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1000

real 0m1.657s

user 0m0.017s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1000

real 0m1.621s

user 0m0.024s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1000

real 0m1.893s

user 0m0.019s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1000

real 0m1.906s

user 0m0.017s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1000

real 0m1.726s

user 0m0.015s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1000

real 0m1.932s

user 0m0.015s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1000

real 0m1.876s

user 0m0.016s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1000

real 0m2.019s

user 0m0.015s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

2000

real 0m1.519s

user 0m0.042s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

2000

real 0m1.552s

user 0m0.056s

sys 0m0.000s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

2000

real 0m1.904s

user 0m0.049s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

2000

real 0m1.642s

user 0m0.043s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

2000

real 0m1.707s

user 0m0.039s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

2000

real 0m1.895s

user 0m0.056s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

2000

real 0m1.642s

user 0m0.043s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

2000

real 0m1.771s

user 0m0.063s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

2000

real 0m2.455s

user 0m0.052s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

2000

real 0m2.497s

user 0m0.050s

sys 0m0.000s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ exit

Script done on 2018-02-08 16:43:58-0800

**Test2.cpp**

Script started on 2018-02-11 12:49:21-0800

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

25000

real 0m7.636s

user 0m0.013s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

25000

real 0m2.834s

user 0m0.012s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

25000

real 0m3.256s

user 0m0.013s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output250[K[K[K

25000

real 0m2.513s

user 0m0.015s

sys 0m0.000s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

25000

real 0m2.352s

user 0m0.011s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

25000

real 0m4.296s

user 0m0.014s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

25000

real 0m2.658s

user 0m0.013s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

25000

real 0m2.385s

user 0m0.014s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

25000

real 0m4.988s

user 0m0.012s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

25000

real 0m2.321s

user 0m0.012s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

50000

real 0m7.750s

user 0m0.019s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

50000

real 0m1.999s

user 0m0.020s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

50000

real 0m3.845s

user 0m0.020s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

50000

real 0m2.737s

user 0m0.020s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

50000

real 0m2.697s

user 0m0.020s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

50000

real 0m2.808s

user 0m0.019s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

50000

real 0m3.554s

user 0m0.022s

sys 0m0.000s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

50000

real 0m2.889s

user 0m0.019s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

50000

real 0m2.402s

user 0m0.020s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

50000

real 0m2.505s

user 0m0.018s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m4.960s

user 0m0.039s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m3.027s

user 0m0.034s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m3.510s

user 0m0.033s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m2.516s

user 0m0.032s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m3.003s

user 0m0.033s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m2.746s

user 0m0.032s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m3.295s

user 0m0.031s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m2.918s

user 0m0.035s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ 1000[K[K[K[Ktime ./a.out > output

100000

real 0m2.401s

user 0m0.028s

sys 0m0.005s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m2.443s

user 0m0.033s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m3.722s

user 0m0.059s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m2.213s

user 0m0.063s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m2.673s

user 0m0.057s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m2.678s

user 0m0.063s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m4.517s

user 0m0.063s

sys 0m0.000s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m2.764s

user 0m0.062s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m2.572s

user 0m0.059s

sys 0m0.004s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m2.829s

user 0m0.060s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m2.698s

user 0m0.060s

sys 0m0.004s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m3.499s

user 0m0.057s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m5.914s

user 0m0.109s

sys 0m0.004s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m4.355s

user 0m0.115s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m2.987s

user 0m0.114s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m2.558s

user 0m0.117s

sys 0m0.004s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m2.490s

user 0m0.111s

sys 0m0.004s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m3.170s

user 0m0.113s

sys 0m0.005s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m2.869s

user 0m0.121s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m2.309s

user 0m0.114s

sys 0m0.006s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m2.266s

user 0m0.121s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m2.556s

user 0m0.112s

sys 0m0.006s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m5.433s

user 0m0.232s

sys 0m0.006s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m2.478s

user 0m0.237s

sys 0m0.008s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m3.561s

user 0m0.243s

sys 0m0.011s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m2.613s

user 0m0.236s

sys 0m0.008s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m2.960s

user 0m0.232s

sys 0m0.010s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m2.671s

user 0m0.220s

sys 0m0.010s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m3.109s

user 0m0.227s

sys 0m0.008s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m2.437s

user 0m0.238s

sys 0m0.005s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m3.041s

user 0m0.222s

sys 0m0.009s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m2.542s

user 0m0.296s

sys 0m0.004s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ exit

Script done on 2018-02-11 12:53:53-0800

**Test3.cpp**

Script started on 2018-02-11 12:54:17-0800

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m10.514s

user 0m0.018s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m2.102s

user 0m0.018s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m1.964s

user 0m0.017s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m2.292s

user 0m0.019s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m2.174s

user 0m0.020s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m2.012s

user 0m0.018s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m2.116s

user 0m0.019s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m1.988s

user 0m0.019s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m2.345s

user 0m0.019s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

100000

real 0m2.269s

user 0m0.018s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m4.334s

user 0m0.031s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m2.166s

user 0m0.032s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m2.318s

user 0m0.027s

sys 0m0.005s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m2.125s

user 0m0.030s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m2.262s

user 0m0.030s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m2.187s

user 0m0.031s

sys 0m0.001s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m2.237s

user 0m0.030s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m2.148s

user 0m0.029s

sys 0m0.004s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m2.236s

user 0m0.030s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

200000

real 0m2.405s

user 0m0.031s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m4.799s

user 0m0.053s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m2.518s

user 0m0.050s

sys 0m0.006s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m4.447s

user 0m0.053s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m2.149s

user 0m0.047s

sys 0m0.009s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m2.134s

user 0m0.054s

sys 0m0.002s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m2.368s

user 0m0.054s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m2.198s

user 0m0.051s

sys 0m0.005s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m2.480s

user 0m0.052s

sys 0m0.006s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m2.198s

user 0m0.050s

sys 0m0.005s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

400000

real 0m2.580s

user 0m0.052s

sys 0m0.004s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m4.449s

user 0m0.099s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m2.823s

user 0m0.098s

sys 0m0.005s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m5.321s

user 0m0.098s

sys 0m0.005s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m7.211s

user 0m0.097s

sys 0m0.006s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m2.689s

user 0m0.096s

sys 0m0.008s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m2.338s

user 0m0.094s

sys 0m0.010s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m2.386s

user 0m0.097s

sys 0m0.007s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m2.777s

user 0m0.101s

sys 0m0.003s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m2.816s

user 0m0.098s

sys 0m0.005s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

800000

real 0m2.939s

user 0m0.098s

sys 0m0.004s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1600000

real 0m9.787s

user 0m0.198s

sys 0m0.018s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1600000

real 0m3.541s

user 0m0.208s

sys 0m0.010s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1600000

real 0m3.269s

user 0m0.204s

sys 0m0.014s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1600000

real 0m4.422s

user 0m0.207s

sys 0m0.012s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1600000

real 0m3.076s

user 0m0.202s

sys 0m0.014s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1600000

real 0m4.588s

user 0m0.238s

sys 0m0.009s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1600000

real 0m3.868s

user 0m0.207s

sys 0m0.011s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1600000

real 0m2.853s

user 0m0.208s

sys 0m0.009s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1600000

real 0m3.364s

user 0m0.205s

sys 0m0.013s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

1600000

real 0m2.654s

user 0m0.204s

sys 0m0.013s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

3200000

real 0m6.191s

user 0m0.451s

sys 0m0.027s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

3200000

real 0m7.286s

user 0m0.449s

sys 0m0.030s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

3200000

real 0m3.674s

user 0m0.455s

sys 0m0.021s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

3200000

real 0m3.867s

user 0m0.460s

sys 0m0.018s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

3200000

real 0m4.088s

user 0m0.452s

sys 0m0.025s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

3200000

real 0m4.273s

user 0m0.455s

sys 0m0.020s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

3200000

real 0m4.192s

user 0m0.446s

sys 0m0.036s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

3200000

real 0m3.849s

user 0m0.450s

sys 0m0.025s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

3200000

real 0m6.121s

user 0m0.457s

sys 0m0.020s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

3200000

real 0m4.476s

user 0m0.451s

sys 0m0.024s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

6400000

real 0m5.774s

user 0m0.932s

sys 0m0.044s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

6400000

real 0m5.140s

user 0m0.941s

sys 0m0.042s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

6400000

real 0m4.542s

user 0m0.922s

sys 0m0.057s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

6400000

real 0m4.350s

user 0m0.944s

sys 0m0.044s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

6400000

real 0m4.783s

user 0m0.932s

sys 0m0.056s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

6400000'

real 0m7.301s

user 0m0.944s

sys 0m0.038s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

6400000

real 0m5.457s

user 0m0.939s

sys 0m0.044s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

6400000

real 0m5.068s

user 0m0.931s

sys 0m0.048s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

6400000

real 0m6.401s

user 0m0.938s

sys 0m0.042s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ time ./a.out > output

6400000

real 0m5.097s

user 0m0.936s

sys 0m0.043s

]0;005670557@csusb.edu@jb358-0:~/cse330/hw2[005670557@csusb.edu@jb358-0 hw2]$ exit

Script done on 2018-02-11 13:00:02-0800

1. **Comparing analysis to run time**

Test1.cpp assuming O(n²), c remains relatively constant



Test2.cpp assuming O(n), c remains relatively constant



Test3.cpp assuming O(n), c remains relatively constant



1. **Worst-case run times**

From the charts above we can see that

-Test1.cpp is of O(n²) were n is the size of the array

-Test2.cpp is of O(n) were n is the size of the array

-Test3.cpp is of O(n) were n is the size of the array