DSA Lab-04 Tasks

Name:	Syed Muhammad Raza Ali
Enrolment:	02-134231-028
Course:	DSA Lab
Faculty:	Miss Rabia

Lab 4: Algorithm Analysis

Objective(s): Upon completion of this lab session, students will be able to:

Study the experimental ways to analyze the time complexity of different algorithms.

Exercise 1: Library Books sorting

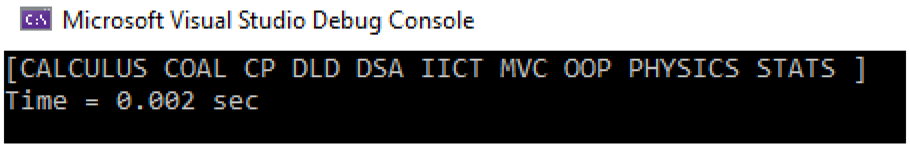
You've been assigned to evaluate sorting algorithms for organizing a cluttered stack of computer science books in the library based on their titles alphabetically. Your task is to compare insertion sort and selection sort in terms of their efficiency in arranging the books. Write a C++ program to implement these algorithms and assess their performance. Recommend the most suitable algorithm for streamlining book organization in the library, ensuring a tidy and efficient arrangement for patrons to locate books easily.

Code:

Using insertion sort

```
#include <iostream>
#include <string>
#include<math.h>
#include<chrono>
using namespace std;

int main() {

	string arr[10] =
{ "IICT","CP","DSA","CALCULUS","MVC","OOP","PHYSICS","DLD","COAL","STATS" };



	clock_t c_start, c_end;
	c_start = clock();

	string key;
	int j;
	for (int i = 0;i < 10;i++) {
		key = arr[i];
		j = i - 1;
		while (j >= 0 && arr[j] > key) {
			arr[j + 1] = arr[j];
			j = j - 1;
		}
		arr[j + 1] = key;
	}
	cout << "[";
	for (int i = 0;i < 10;i++) {
		cout << arr[i] << " ";
```

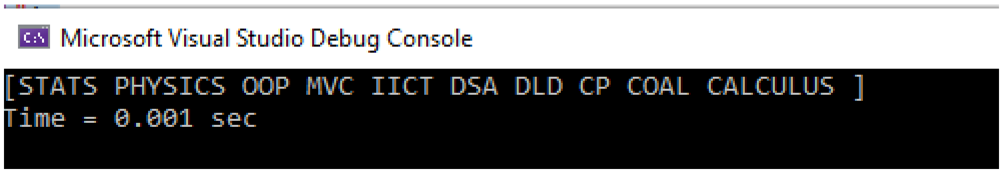
```
        }
        cout << "]";

        c_end = clock();
        double time;
        time = (double)(c_end - c_start) / (double)CLOCKS_PER_SEC;
        cout << "\nTime = " << time << " sec " << endl;


        return 0;
}
```



```
[CALCULUS COAL CP DLD DSA IICT MVC OOP PHYSICS STATS ]
Time = 0.002 sec
```

Using selection sort

```
#include <iostream>
#include <string>
#include<math.h>
#include<chrono>
using namespace std;

int main() {

        string arr[10] =
{ "IICT","CP","DSA","CALCULUS","MVC","OOP","PHYSICS","DLD","COAL","STATS" };


        clock_t c_start, c_end;
        c_start = clock();
        string temp;

        for (int i = 0; i < 10; i++) {
                for (int j = i + 1; j < 10; j++) {
                        if (arr[j] > arr[i]) {
                                temp = arr[j];
                                arr[j] = arr[i];
                                arr[i] = temp;
                        }
                }
        }

        cout << "[";
        for (int i = 0;i < 10;i++) {
                cout << arr[i] << " ";
        }
        cout << "]";

        c_end = clock();
        double time;
        time = (double)(c_end - c_start) / (double)CLOCKS_PER_SEC;
        cout << "\nTime = " << time << " sec " << endl;


        return 0;}
```



```
[STATS PHYSICS OOP MVC IICT DSA DLD CP COAL CALCULUS ]
Time = 0.001 sec
```

Conclusion: Selection sort is taking less time so it is more efficient

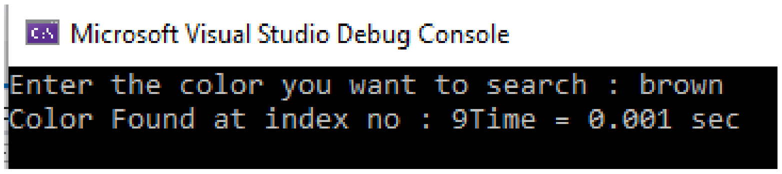
Exercise 2: Ball in the box

At a toy manufacturing company, you need to develop a search algorithm to find a specific colored ball in a large box having 10 different colored balls. Write a C++ program to implement and compare linear and binary search, where you aim to determine the most efficient method, analyze their time complexity and runtime performance, and recommend the best approach for quickly locating the desired ball, optimizing customer service.

Code:

Using Linear search

```
#include <iostream>
#include <string>
#include<math.h>
#include<chrono>
using namespace std;

int main() {

	string arr[10] = 
{"red","green","blue","orange","yellow","pink","white","black","purple","brow
n"};

	cout << "Enter the color you want to search : ";
	string colorName;
	cin >> colorName;


	clock_t c_start, c_end;
	c_start = clock();
	string temp;
	bool flag;

	for (int i = 0;i < 10;i++) {
		if (arr[i] == colorName) {
			cout << "Color Found at index no : " << i;
			flag = true;
		}
	}

	if (!flag) {
		cout << "Color doesnt exist";
	}
	c_end = clock();
	double time;
	time = (double)(c_end - c_start) / (double)CLOCKS_PER_SEC;
	cout << "\nTime = " << time << " sec " << endl;

	return 0;
}
```



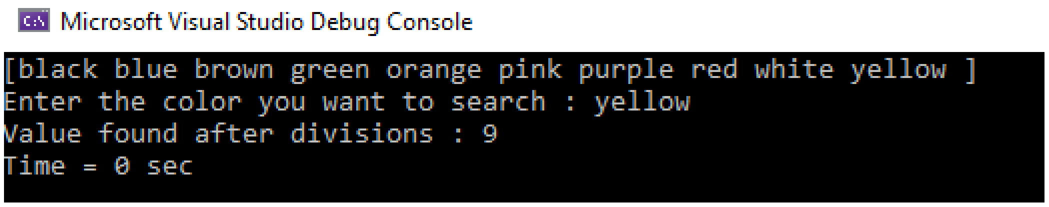
Microsoft Visual Studio Debug Console

```
Enter the color you want to search : brown
Color Found at index no : 9Time = 0.001 sec
```

Using Binary Search

```
#include <iostream>
#include <string>
#include<math.h>
#include<chrono>
using namespace std;

int main() {

	string arr[10] =
{"red","green","blue","orange","yellow","pink","white","black","purple","brow
n"};
	string temp;


	for (int i = 0; i < 10; i++) {
		for (int j = i + 1; j < 10; j++) {
			if (arr[j] < arr[i]) {
				temp = arr[j];
				arr[j] = arr[i];
				arr[i] = temp;
			}
		}
	}

	cout << "[";
	for (int i = 0;i < 10;i++) {
		cout << arr[i] << " ";
	}
	cout << "]";
	cout << "\nEnter the color you want to search : ";
	string colorName;
	cin >> colorName;

	clock_t c_start, c_end;
	c_start = clock();


	int beg = 0;
	int end = 9;
	int mid = (beg + end) / 2;
```

```
        while (beg <= end && arr[mid] != colorName) {
                if (colorName < arr[mid])
                        end = mid - 1;
                else
                        beg = mid + 1;
                mid = (beg + end) / 2;
        }
        bool flag = false;
        if (arr[mid] == colorName)
                flag = true;
        if (flag)
                cout << "Value found after divisions : " << mid;
        else
                cout << "Value doesn't exist";



        c_end = clock();
        double time;
        time = (double)(c_end - c_start) / (double)CLOCKS_PER_SEC;
        cout << "\nTime = " << time << " sec " << endl;

        return 0;
}
```


Microsoft Visual Studio Debug Console

```
[black blue brown green orange pink purple red white yellow ]
Enter the color you want to search : yellow
Value found after divisions : 9
Time = 0 sec
```

Conclusion: Binary search is taking less time so it is more efficient

Exercise 3

Consider the following array. Write a program to determine the time taken to search following elements using linear search and binary

Item=44

Item=400

Item=450

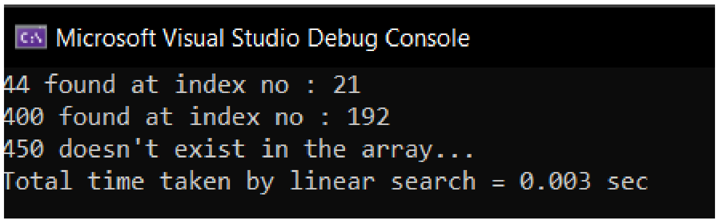
{2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32,34,36,38,40,42,44,46,48,50,52,54,56,58,60,
62,64,66,68,70,72,74,76,78,80,82,84,86,88,90,92,100,102,104,106,108,110,112,114,116,
118,120,122,124,126,128,130,132,134,136,138,140,142,144,146,148,150,152,154,156,15
8,160,162,164,166,168,169,170,172,174,176,178,180,182,184,186,188,190,192,194,196,
198,200,202,204,206,208,210,212,214,216,218,220,222,224,226,228,230,232,234,236,23
238,240,242,244,246,248,250,252,254,256,258,260,262,264,266,268,270,272,274,276,27
8,280,282,284,286,288,300,302,304,306,308,310,312,314,316,318,320,322,324,326,328,
330,332,334,336,338,340,342,344,346,348,350,352,354,356,358,360,362,364,366,368,37
0,372,374,376,378,380,382,384,386,388,390,392,394,396,398,400}

Code:

Using Linear Search

```
#include <iostream>
#include <chrono>
using namespace std;

int main() {

	int arr[193] = { 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28,
30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66,
68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 100, 102, 104, 106, 108,
110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138,
140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168,
169, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196,
198, 200, 202, 204, 206, 208, 210, 212, 214, 216, 218, 220, 222, 224, 226,
228, 230, 232, 234, 236, 23238, 240, 242, 244, 246, 248, 250, 252, 254, 256,
258, 260, 262, 264, 266, 268, 270, 272, 274, 276, 278, 280, 282, 284, 286,
288, 300, 302, 304, 306, 308, 310, 312, 314, 316, 318, 320, 322, 324, 326,
328, 330, 332, 334, 336, 338, 340, 342, 344, 346, 348, 350, 352, 354, 356,
358, 360, 362, 364, 366, 368, 370, 372, 374, 376, 378, 380, 382, 384, 386,
388, 390, 392, 394, 396, 398, 400 };
	bool flag = false;

	clock_t c_start, c_end;
	c_start = clock();

	for (int i = 0; i < 193; i++) {
		if (arr[i] == 44) {
			cout << "44 found at index no : " << i << endl;
		}
	}
	for (int i = 0; i < 193; i++) {
		if (arr[i] == 400) {
			cout << "400 found at index no : " << i << endl;
		}
	}
	for (int i = 0; i < 193; i++) {
		if (arr[i] == 450) {
			flag = true;
			cout << "450 found at index no : " << i << endl;
		}
	}
```

```
        if (!flag)
                cout << "450 doesn't exist in the array...";

        c_end = clock();
        double time;
        time = (double)(c_end - c_start) / (double)CLOCKS_PER_SEC;
        cout << "\nTotal time taken by linear search = " << time << " sec " <<
endl;

        return 0;
}
```

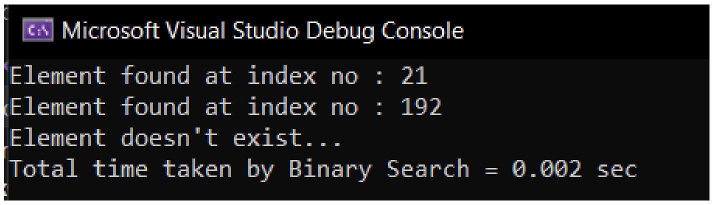


```
Microsoft Visual Studio Debug Console
44 found at index no : 21
400 found at index no : 192
450 doesn't exist in the array...
Total time taken by linear search = 0.003 sec
```

Using Binary Search

```
#include <iostream>
#include <chrono>
using namespace std;

int main() {

        int arr[193] = { 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28,
30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66,
68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 100, 102, 104, 106, 108,
110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138,
140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168,
169, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196,
198, 200, 202, 204, 206, 208, 210, 212, 214, 216, 218, 220, 222, 224, 226,
228, 230, 232, 234, 236, 23238, 240, 242, 244, 246, 248, 250, 252, 254, 256,
258, 260, 262, 264, 266, 268, 270, 272, 274, 276, 278, 280, 282, 284, 286,
288, 300, 302, 304, 306, 308, 310, 312, 314, 316, 318, 320, 322, 324, 326,
328, 330, 332, 334, 336, 338, 340, 342, 344, 346, 348, 350, 352, 354, 356,
358, 360, 362, 364, 366, 368, 370, 372, 374, 376, 378, 380, 382, 384, 386,
388, 390, 392, 394, 396, 398, 400 };
        int beg = 0;
        int end = 192;
        int mid = (beg + end) / 2;

        clock_t c_start, c_end;
        c_start = clock();

        while (beg <= end && arr[mid] != 44) {
                if (44 < arr[mid])
                        end = mid - 1;
                else
                        beg = mid + 1;
                mid = (beg + end) / 2;
        }
        if (arr[mid] == 44)
                cout << "Element found at index no : " << mid;
        else
```

```
		cout << "Element doesn't exist...";

	 beg = 0;
	 end = 192;
	 mid = (beg + end) / 2;
	while (beg <= end && arr[mid] != 400) {
		if (400 < arr[mid])
			end = mid - 1;
		else
			beg = mid + 1;
		mid = (beg + end) / 2;
	}
	if (arr[mid] == 400)
		cout << "\nElement found at index no : " << mid;
	else
		cout << "Element doesn't exist...";

	beg = 0;
	end = 192;
	mid = (beg + end) / 2;
	while (beg <= end && arr[mid] != 450) {
		if (450 < arr[mid])
			end = mid - 1;
		else
			beg = mid + 1;
		mid = (beg + end) / 2;
	}
	if (arr[mid] == 450)
		cout << "\nElement found at index no : " << mid;
	else
		cout << "\nElement doesn't exist...";

	c_end = clock();
	double time;
	time = (double)(c_end - c_start) / (double)CLOCKS_PER_SEC;
	cout << "\nTotal time taken by Binary Search = " << time << " sec " <<
endl;


	return 0;
}
```



Microsoft Visual Studio Debug Console

```
Element found at index no : 21
Element found at index no : 192
Element doesn't exist...
Total time taken by Binary Search = 0.002 sec
```

Exercise 4

Write programs for following two different algorithms for finding that given number is prime or not. Also determine the time taken by both algorithms

Frist Algorithm

```
for i ← 2 to n-1
    if i divides n
        n is not prime number
```

Second Algorithm

```
for i ← 2 to √n
    if i divides n
        n is not prime number
```

.

Calculate times taken by these programs for given values and conclude which algorithm is better than other

i. n = 11

ii. n = 101

iii. n = 1111

iv. n = 1000003

v. n =

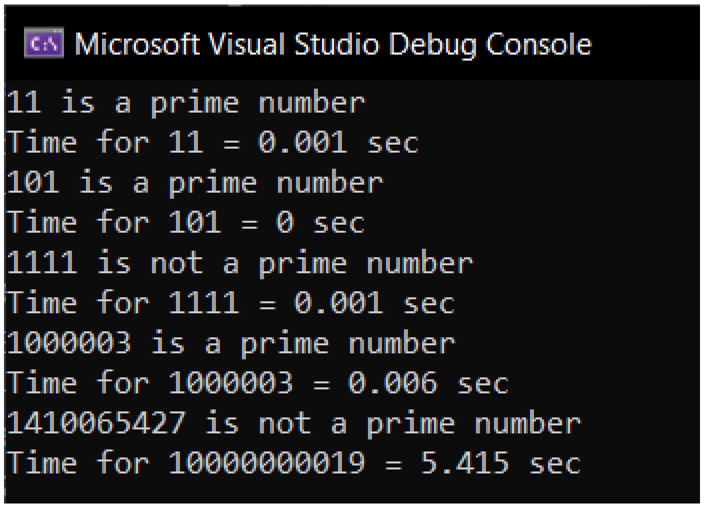
Plot graphs for time of execution vs. “n”, for all the values of n given .Use excel for plotting graph.

Code:

```
#include <iostream>
#include <chrono>
using namespace std;

int main() {
	int n1 = 11;
	int n2 = 101;
	int n3 = 1111;
	int n4 = 1000003;
	int n5 = 10000000019;

	clock_t c_start1, c_end1;
	c_start1 = clock();
	bool isPrime1 = true;
	for (int i = 2; i < n1; i++) {
		if (n1 % i == 0)
			isPrime1 = false;
	}
	if (isPrime1)
		cout << n1 << " is a prime number";
	c_end1 = clock();
```

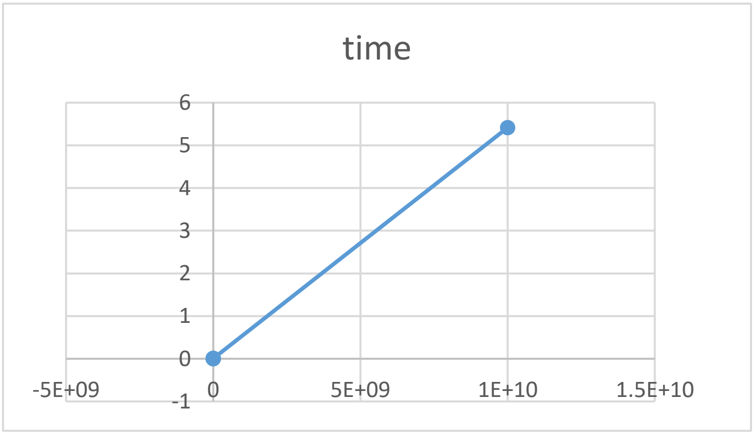
```cpp
double time1 = (double)(c_end1 - c_start1) / (double)CLOCKS_PER_SEC;
cout << "\nTime for 11 = " << time1 << " sec " << endl;

clock_t c_start2, c_end2;
c_start2 = clock();
bool isPrime2 = true;
for (int i = 2; i < n2; i++) {
	if (n2 % i == 0)
		isPrime2 = false;
}
if (isPrime2)
	cout << n2 << " is a prime number";
c_end2 = clock();

double time2 = (double)(c_end2 - c_start2) / (double)CLOCKS_PER_SEC;
cout << "\nTime for 101 = " << time2 << " sec " << endl;



clock_t c_start3, c_end3;
c_start3 = clock();
bool isPrime3 = true;
for (int i = 3; i < n3; i++) {
	if (n3 % i == 0)
		isPrime3 = false;
}
if (isPrime3)
	cout << n3 << " is a prime number";
else
	cout << n3 << " is not a prime number";
c_end3 = clock();

double time3 = (double)(c_end3 - c_start3) / (double)CLOCKS_PER_SEC;
cout << "\nTime for 1111 = " << time3 << " sec " << endl;



clock_t c_start4, c_end4;
c_start4 = clock();
bool isPrime4 = true;
for (int i = 4; i < n4; i++) {
	if (n4 % i == 0)
		isPrime4 = false;
}
if (isPrime4)
	cout << n4 << " is a prime number";
c_end4 = clock();

double time4 = (double)(c_end4 - c_start4) / (double)CLOCKS_PER_SEC;
cout << "\nTime for 1000003 = " << time4 << " sec " << endl;

clock_t c_start5, c_end5;
c_start5 = clock();
bool isPrime5 = true;
for (int i = 5; i < n5; i++) {
	if (n5 % i == 0)
		isPrime5 = false;
```

```
        }
        if (isPrime5)
                cout << n5 << " is a prime number";
        else
                cout << n5 << " is not a prime number";
        c_end5 = clock();

        double time5 = (double)(c_end5 - c_start5) / (double)CLOCKS_PER_SEC;
        cout << "\nTime for 10000000019 = " << time5 << " sec " << endl;

        return 0;
}
```



Microsoft Visual Studio Debug Console

```
11 is a prime number
Time for 11 = 0.001 sec
101 is a prime number
Time for 101 = 0 sec
1111 is not a prime number
Time for 1111 = 0.001 sec
1000003 is a prime number
Time for 1000003 = 0.006 sec
1410065427 is not a prime number
Time for 10000000019 = 5.415 sec
```


time
-5E+09
5E+09
1E+10
1.5E+10