

```
1  #include "SampleStatistics.h"
2  #include "Sorting.h"
3  #include <stdlib.h>
4  #include <iostream>
5  #include <iomanip>
6  #include <vector>
7  #include <chrono>
8  using namespace std::chrono;
9  using namespace std;
10
11 // https://www.geeksforgeeks.org/measure-execution-time-function-cpp/
12
13 char GetSubOption(char title[])
14 {
15     char line[128];
16     cout << title << endl;
17     cout << "1 Insertion Sort" << endl;
18     cout << "2 Selection Sort" << endl;
19     cout << "3 Heap Sort" << endl;
20     cout << "4 Quick Sort" << endl;
21     cout << "5 Singleton's Sort" << endl;
22     cout << "6 Tree Sort 3" << endl;
23     cout << "7 Exit Submenu" << endl;
24     cout << "8 Exit Program" << endl;
25     cout << "Suboption Number: ";
26     cin.getline(line, 128);
27     return line[0];
28 }
29
30 char DoSort(char option) {
31     char subOption, line[128];
32     char title[128] = { 0 };
33     char name[6][64] = { { 0 } };
34     strcpy_s(name[0], 64, "Insertion Sort");
35     strcat_s(name[1], 64, "Selection Sort");
36     strcat_s(name[2], 64, "Heap Sort");
37     strcat_s(name[3], 64, "Quick Sort");
38     strcat_s(name[4], 64, "Singleton's Sort");
39     strcat_s(name[5], 64, "Tree Sort 3");
40     vector<double> runtime;
41     if (option == '1')
42     {
43         strcpy_s(title, 128, "Single Sorting Tests Submenu");
44     }
45     else {
46         strcpy_s(title, 128, "Statistical Sorting Tests Submenu");
47     }
48     subOption = GetSubOption(title);
49     if (subOption < '1' || subOption > '8') {
50         cout << "Illegal Suboption Exiting Application!" << endl;
51         exit(-1);
52     }
```

```
53     if (subOption == '7' || subOption == '8') {
54         return subOption;
55     }
56     int index = (int)(subOption - '1');
57     cout << name[index] << endl;
58     cout << "PRNG Seed          = ";
59     cin.getline(line, 128);
60     int seed = atoi(line);
61     cout << "Number of Samples      = ";
62     cin.getline(line, 128);
63     int n = atoi(line);
64     cout << "Maximum Sample Value = ";
65     cin.getline(line, 128);
66     int maximum = atoi(line);
67     srand(seed);
68     int number;
69     if (option == '2') {
70         cout << "Number of Experiments = ";
71         cin.getline(line, 128);
72         number = atoi(line);
73     }
74     else {
75         number = 1;
76     }
77     double* sample = new double[n];
78     double* shadow = new double[n];
79     for (int i = 0; i < number; i++) {
80         for (int j = 0; j < n; j++) {
81             sample[j] = rand() % maximum;
82             if (option == '1') {
83                 shadow[j] = sample[j];
84             }
85         }
86         auto start = high_resolution_clock::now();
87         switch (subOption) {
88             case '1':
89                 Sorting::InsertionSort(sample, n);
90                 break;
91             case '2':
92                 Sorting::SelectionSort(sample, n);
93                 break;
94             case '3':
95                 Sorting::HeapSort(sample, n);
96                 break;
97             case '4':
98                 Sorting::QuickSort(sample, n);
99                 break;
100            case '5':
101                Sorting::SingletonsSort(sample, n);
102                break;
103            case '6':
104                Sorting::TreeSort3(sample, n);
```

```
105         break;
106     default:
107         cout << "Unknown Suboption" << endl;
108         break;
109     }
110     auto stop = high_resolution_clock::now();
111     auto duration = duration_cast<microseconds>(stop - start);
112     double rt = (double)duration.count();
113     runtime.push_back(rt);
114 }
115 if (option == '1') {
116     for (int i = 0; i < n; i++) {
117         cout << setw(2) << shadow[i] << ' ';
118         cout << setw(2) << sample[i] << endl;
119     }
120 }
121 else if (option == '2') {
122     cout << "Runtimes in Microseconds" << endl;
123     cout << "Minimum Runtime          = "
124         << setw(4) << fixed << setprecision(0)
125         << SampleStatistics::Min(runtime) << endl;
126     cout << "Maximum Runtime          = "
127         << setw(4) << fixed << setprecision(0)
128         << SampleStatistics::Max(runtime) << endl;
129     cout << "Mean Runtime              = "
130         << setw(4) << fixed << setprecision(0)
131         << SampleStatistics::Mean(runtime) << endl;
132     cout << "Median Runtime             = "
133         << setw(4) << fixed << setprecision(0) <<
134         SampleStatistics::Median(runtime) << endl;
135 }
136 delete[] sample;
137 delete[] shadow;
138 return subOption;
139 }
140
141 int main() {
142     while (true) {
143         char line[128];
144         cout << "Menu" << endl;
145         cout << "1 Single Sorting Tests" << endl;
146         cout << "2 Statistical Tests" << endl;
147         cout << "3 Exit" << endl;
148         cout << "Option number: ";
149         cin.getline(line, 128);
150         if (line[0] == '3')
151             break;
152         if (line[0] == '1' || line[0] == '2') {
153             while (true)
154             {
155                 char doSort = DoSort(line[0]);
156                 if (doSort == '7')
```

```
157         break;
158     else if (doSort == '8')
159         exit(1);
160     }
161 }
162 }
163 return 0;
164 }
```