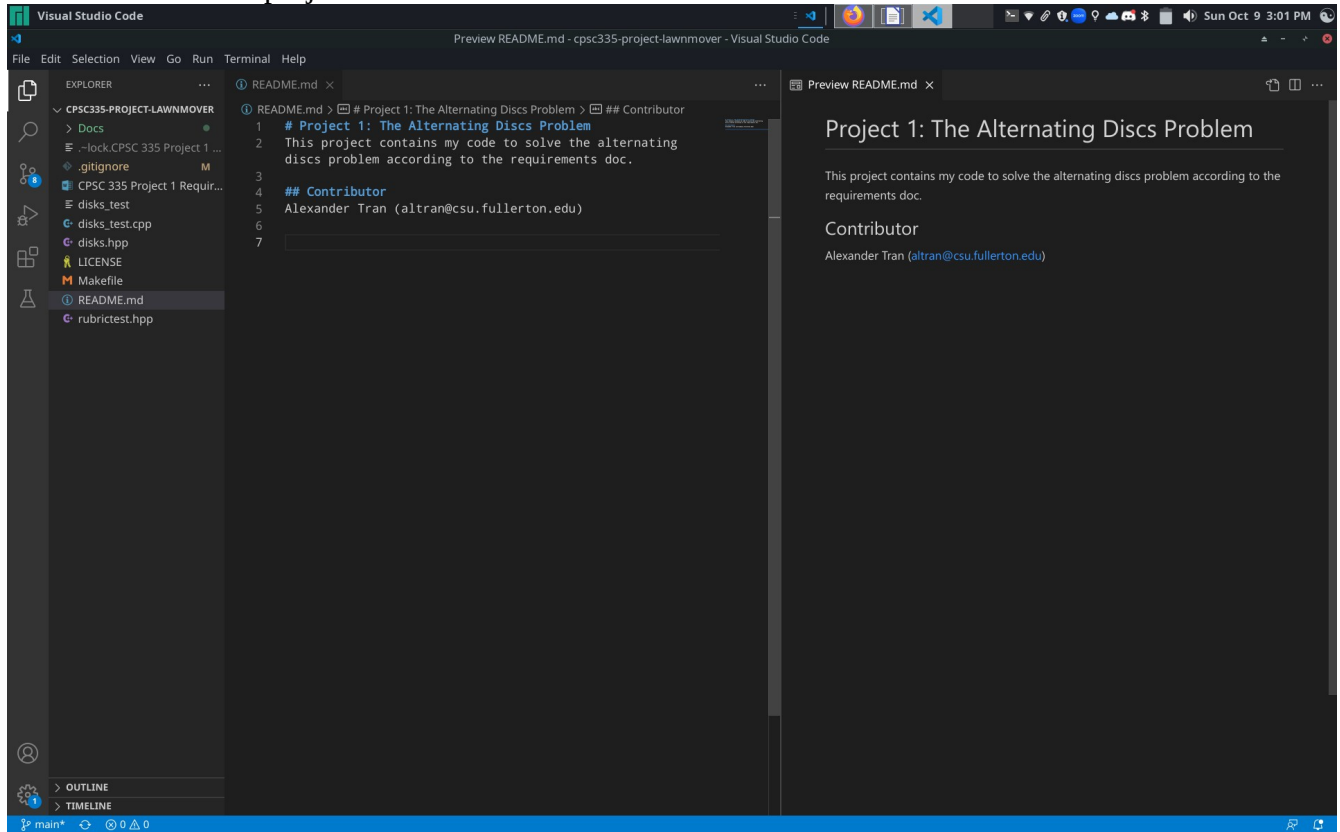


Project Contributor

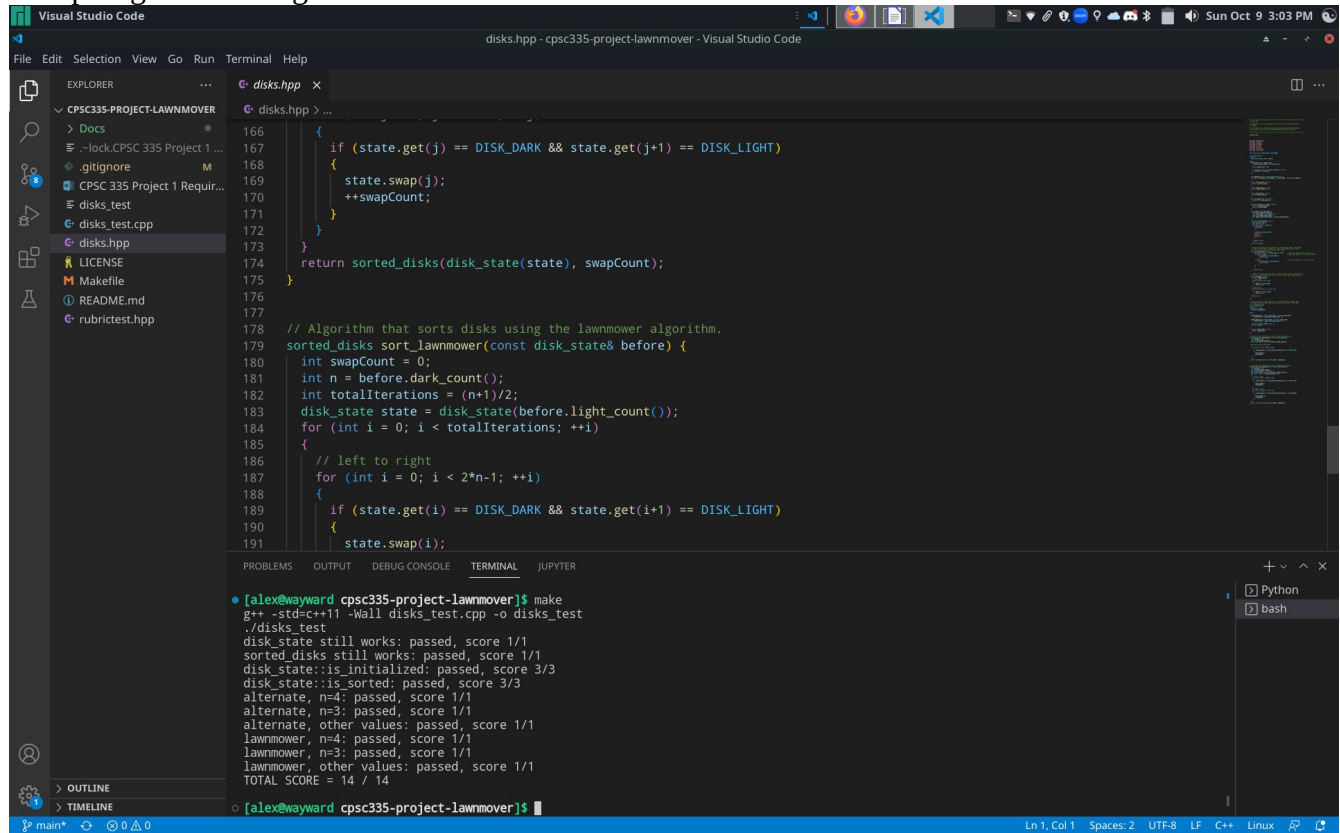
Alexander Tran (altran@csu.fullerton.edu)

Screenshots

README.md with project contributor name



Compiling and running



The screenshot shows the Visual Studio Code interface. The Explorer pane on the left shows the project structure for 'CPSC335-PROJECT-LAWNMOWER'. The main editor displays the 'disks.hpp' file, which contains the implementation of the Lawnmower algorithm. The code includes a `sorted_disks` function and a `sort_lawnmower` function. The terminal at the bottom shows the command to compile and run the tests, and the output displays the results of various tests, including 'disk_state::is_initialized', 'disk_state::is_sorted', 'alternate', 'lawnmower', and 'TOTAL SCORE'.

```
166
167
168     if (state.get(j) == DISK_DARK && state.get(j+1) == DISK_LIGHT)
169     {
170         state.swap(j);
171         ++swapCount;
172     }
173 }
174 return sorted_disks(disk_state(state), swapCount);
175 }
176
177 // Algorithm that sorts disks using the lawnmower algorithm.
178 sorted_disks sort_lawnmower(const disk_state& before) {
179     int swapCount = 0;
180     int n = before.dark_count();
181     int totalIterations = (n+1)/2;
182     disk_state state = disk_state(before.light_count());
183     for (int i = 0; i < totalIterations; ++i)
184     {
185         // left to right
186         for (int i = 0; i < 2*n-1; ++i)
187         {
188             if (state.get(i) == DISK_DARK && state.get(i+1) == DISK_LIGHT)
189             {
190                 state.swap(i);
191             }
192         }
193     }
194 }
```

```
[alex@wayward cpssc335-project-lawnmover]$ make
g++ -std=c++11 -Wall disks_test.cpp -o disks_test
./disks_test
disk_state still works: passed, score 1/1
sorted_disks still works: passed, score 1/1
disk_state::is_initialized: passed, score 3/3
disk_state::is_sorted: passed, score 3/3
alternate, n=4: passed, score 1/1
alternate, n=3: passed, score 1/1
alternate, other values: passed, score 1/1
lawnmower, n=4: passed, score 1/1
lawnmower, n=3: passed, score 1/1
lawnmower, other values: passed, score 1/1
TOTAL SCORE = 14 / 14
[alex@wayward cpssc335-project-lawnmover]$
```

The Algorithms

Let l be the given list of size $2n$ in any pseudocode presented.

Lawnmower

```
def lawnmower( $n, l$ ):
    iterations =  $(n+1)/2$ 
    for _ from 0 to iterations:
        # LEFT TO RIGHT
        for  $i$  from 0 to  $2*n-1$ :
            if  $l[i] == 1$  and  $l[i+1] == 0$ :
                swap( $l[i], l[i+1]$ )
        # RIGHT TO LEFT
        for  $i$  from  $2*n-1$  to 0 in steps of -1:
            if  $l[i] == 0$  and  $l[i-1] == 1$ :
                swap( $l[i], l[i-1]$ )
```

Step count formula: $6n^2+3n-3$

Proof: Lawnmower algorithm has time complexity of $O(n^2)$

Let:

$$f(n) = 6n^2 + 3n - 3,$$

$$g(n) = n^2,$$

$$c = |6| + |3| + |-3| = 12,$$

and $n_0 = 5$ (an arbitrary value).

By definition, $f(n)$ is in the order of $g(n)$ if $f(n) \leq c * g(n)$ where $n \leq n_0$.

$$\begin{aligned} f(n) &\leq c * g(n) \\ 6n^2 + 3n - 3 &\leq 12 * n^2 \\ 6(5)^2 + 3(5) - 3 &\leq 12 * (5)^2 \\ 150 + 15 - 3 &\leq 300 \\ 162 &\leq 300 \end{aligned}$$

Thus, $6n^2 + 3n - 3$ has a time complexity of $O(n^2)$.

Alternate

```
def alternate(n, l):  
    for i in range(n+1):  
        for j in range(i, 2*n-1):  
            if l[j] == 1 and l[j+1] == 0:  
                swap(l[j], l[j+1])
```

Step count formula: $\frac{3}{2}(3n^2+n-2)$

Proof: the alternate algorithm has time complexity of **$O(n^2)$**

Let:

$$f(n) = \frac{3}{2}(3n^2+n-2),$$

$$g(n) = n^2,$$

$$c = \left\lfloor \frac{9}{2} \right\rfloor + \left\lfloor \frac{3}{2} \right\rfloor + |-3| = 9,$$

and $n_0 = 5$ (an arbitrary value).

By definition, $f(n)$ is in the order of $g(n)$ if $f(n) \leq c * g(n)$ where $n \leq n_0$.

$$f(n) \leq c * g(n)$$

$$\frac{3}{2}(3n^2+n-2) \leq 9 * n^2$$

$$\frac{3}{2}(3(5)^2+(5)-2) \leq 9 * (5)^2$$

$$\frac{3}{2}(75+5-2) \leq 225$$

$$117 \leq 225$$

Thus, $\frac{3}{2}(3n^2+n-2)$ has a time complexity of $O(n^2)$.