Project 1:
Implementing Algorithms

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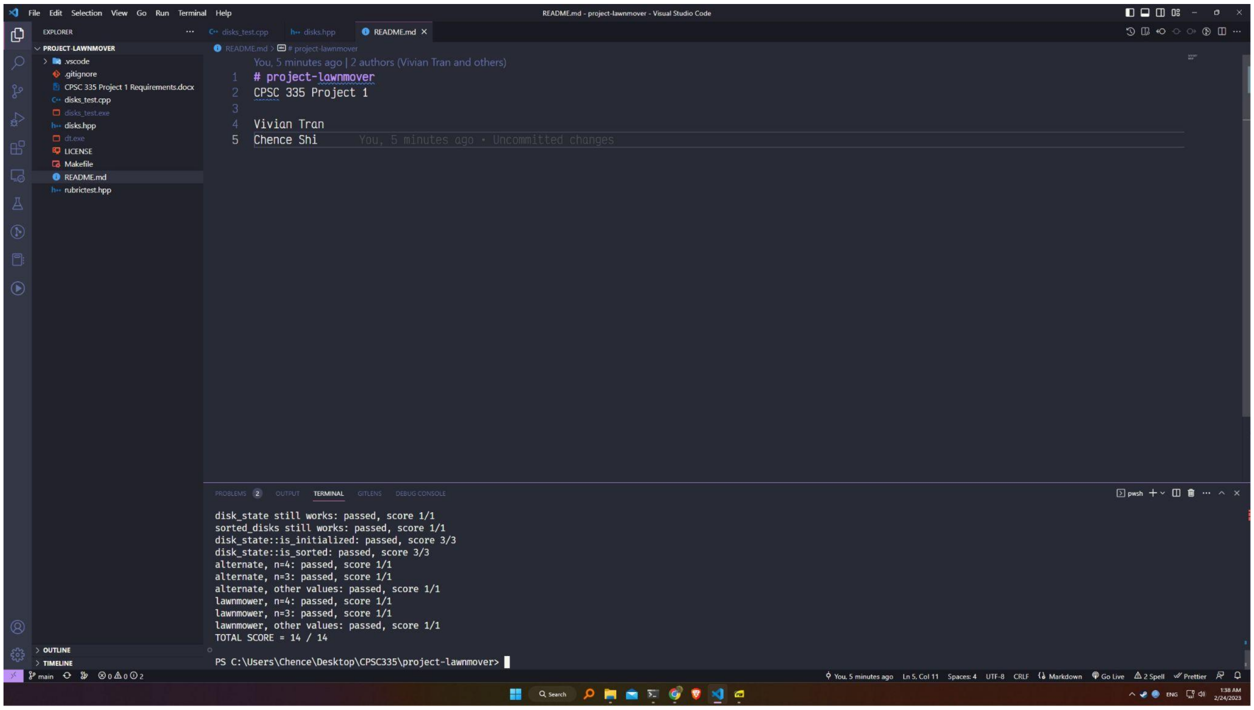
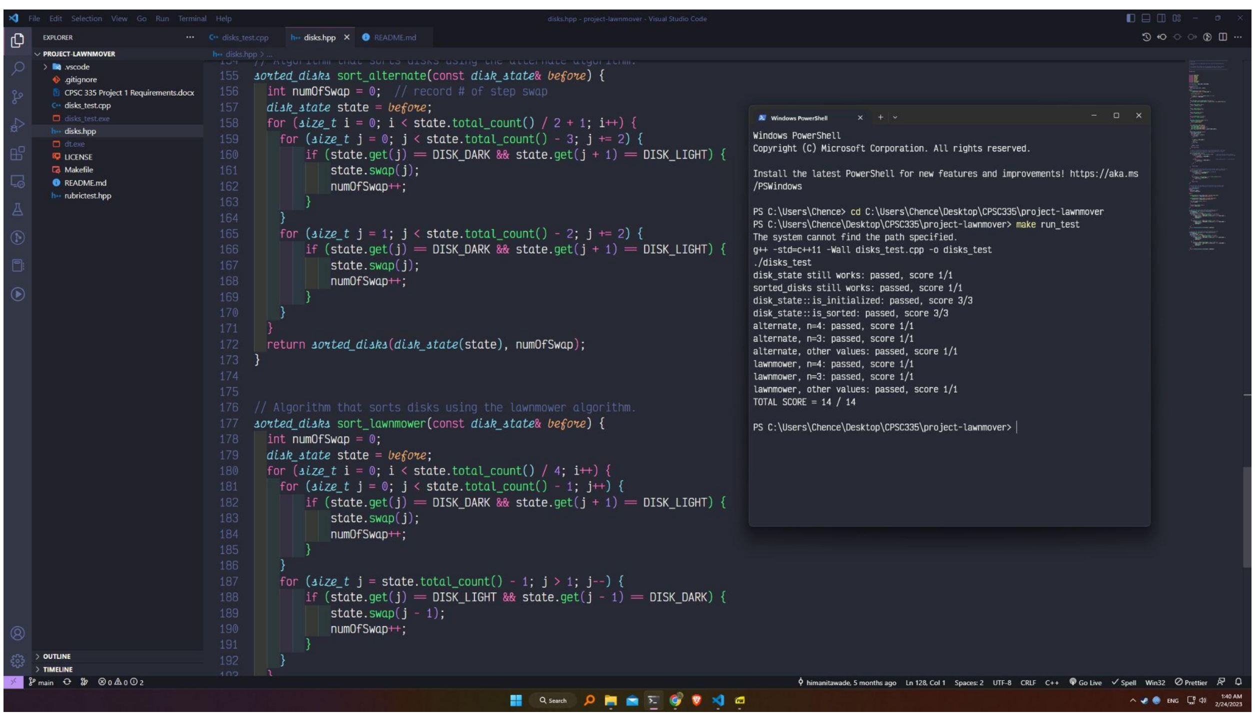
Screenshot


README.md - project-lawnmower - Visual Studio Code
project-lawnmower
CPSC 335 Project 1
Vivian Tran
Chence Shi
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
PS C:\Users\Chence\Desktop\CPSC335\project-lawnmower>


sorted_disks sort_alternate(const disk_state& before) {
int numOfSwap = 0; // record # of step swap
disk_state state = before;
for (size_t i = 0; i < state.total_count() / 2 + 1; i++) {
for (size_t j = 0; j < state.total_count() - 3; j += 2) {
if (state.get(j) == DISK_DARK && state.get(j + 1) == DISK_LIGHT) {
state.swap(j);
numOfSwap++;
}
}
for (size_t j = 1; j < state.total_count() - 2; j += 2) {
if (state.get(j) == DISK_DARK && state.get(j + 1) == DISK_LIGHT) {
state.swap(j);
numOfSwap++;
}
}
}
return sorted_disks(disk_state(state), numOfSwap);
}
// Algorithm that sorts disks using the lawnmower algorithm.
sorted_disks sort_lawnmower(const disk_state& before) {
int numOfSwap = 0;
disk_state state = before;
for (size_t i = 0; i < state.total_count() / 4; i++) {
for (size_t j = 0; j < state.total_count() - 1; j++) {
if (state.get(j) == DISK_DARK && state.get(j + 1) == DISK_LIGHT) {
state.swap(j);
numOfSwap++;
}
}
for (size_t j = state.total_count() - 1; j > 1; j--) {
if (state.get(j) == DISK_LIGHT && state.get(j - 1) == DISK_DARK) {
state.swap(j - 1);
numOfSwap++;
}
}
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.
Install the latest PowerShell for new features and improvements! https://aka.ms/PSWindows
PS C:\Users\Chence> cd C:\Users\Chence\Desktop\CPSC335\project-lawnmower
PS C:\Users\Chence\Desktop\CPSC335\project-lawnmower> make run_test
The system cannot find the path specified.
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
PS C:\Users\Chence\Desktop\CPSC335\project-lawnmower>

Pseudocode

Lawnmower Algorithms:

```
FOR i = 1 to n/2
    FOR j = 1 to 2n-1
        IF disk in j == dark AND disk in j+1 == light THEN
            swap disk in j and j+1
        ENDIF
    ENDFOR
    FOR j = 2n to 2 step -1
        IF disk in j == light AND disk in j-1 == dark THEN
            Swap disk in j and j-1
        ENDIF
    ENDFOR
ENDFOR
```

Alternate Algorithms:

```
FOR i = 1 to n+1
    FOR j = 1 to 2n-3 step 2
        IF disk in j == dark AND disk in j+1 == light THEN
            swap disk in j and j+1
        ENDIF
    ENDFOR
    FOR j = 2 to 2n-2 step 2
        IF disk in j == dark AND disk in j+1 == light THEN
            swap disk in j and j+1
        ENDIF
    ENDFOR
ENDFOR
```

Step Count

lawnmower:

$$\sum_{i=1}^{\frac{n}{2}}\left[\sum_{j=1}^{2n-1}(3+\max(1,0)) + \sum_{j=2}^{2n}(3+\max(1,0))\right]$$

$$= \sum_{i=1}^{\frac{n}{2}}\left[\sum_{j=1}^{2n-1}4 + \sum_{j=2}^{2n}4\right]$$

$$= \sum_{i=1}^{\frac{n}{2}}\left[4\cdot(2n-1-1+1) + 4\cdot(2n-2+1)\right]$$

$$4\cdot(2n-1) + 4(2n-1)$$
$$= 8(2n-1)$$

$$= \sum_{i=1}^{\frac{n}{2}} 8(2n-1)$$

$$= 8\left[\sum_{i=1}^{\frac{n}{2}} 2n - \sum_{i=1}^{\frac{n}{2}} 1\right]$$

$$= 8\left[\frac{n}{2}\cdot 2n - \frac{n}{2}\right]$$

$$= 8\left(n^2 - \frac{n}{2}\right)$$

$$= 8n^2 - 4n$$

Alternate:

$$\sum_{i=1}^{n+1}\left[\sum_{\substack{j=1\\ j+=2}}^{2n-3}\left(3+\max(1,0)\right)+\sum_{\substack{j=2\\ j+=2}}^{2n-2}\left(3+\max(1,0)\right)\right]$$

$$=\sum_{i=1}^{n+1}\left[\sum_{\substack{j=1\\ j+=2}}^{2n-3}4+\sum_{\substack{j=2\\ j+=2}}^{2n-2}4\right]$$

$$=\sum_{i=1}^{n+1}\left[\left(\frac{2n-3-1}{2}+1\right)\cdot 4+\left(\frac{2n-2-2}{2}+1\right)\cdot 4\right]$$

$$=\sum_{i=1}^{n+1}\left[\left(n-2+1\right)\cdot 4+\left(n-2+1\right)\cdot 4\right]$$

$$=\sum_{i=1}^{n+1}\left[(n-1)\cdot 4+(n-1)\cdot 4\right]$$

$$=\sum_{i=1}^{n+1}8(n-1)$$

$$=8\left[\sum_{i=1}^{n+1}n-\sum_{i=1}^{n+1}1\right]$$

$$=8\left[(n+1)n-(n+1)\right]$$

$$=8\left(n^2+n-n-1\right)$$

$$=8n^2-8$$

Proof Argument

Lawnmower Algorithms:

Proof Argument
Lawnmower's Algorithm
In this proof, we will be proving that

$$8n^2 - 4n \in O(n^2)$$

Using Proof of Limits

$f(n) = 8n^2 - 4n$
$g(n) = n^2$

$$\lim_{n \to \infty} \frac{8n^2 - 4n}{n^2} = \lim_{n \to \infty} \frac{8n^2}{n^2} - \lim_{n \to \infty} \frac{4n}{n^2}$$

$$= \lim_{n \to \infty} 8 - \lim_{n \to \infty} \frac{4}{n}$$

$$= 8 - \frac{4}{\infty}$$

$$= 8 - 0$$

$$= 8$$

By limits theorem,

$$8n^2 - 4n \in O(n^2)$$

Alternate Algorithms:

Proof Argument
Alternate Algorithm
In this proof, we will be proving that

$$8n^2 - 8 \in O(n^2)$$

Using Proof of Limits

$f(n) = 8n^2 - 8$
$g(n) = n^2$

$$\lim_{n \to \infty} \frac{8n^2 - 8}{n^2} = \lim_{n \to \infty} 8 - \lim_{n \to \infty} \frac{8}{n^2}$$

$$= 8 - \frac{8}{\infty^2}$$

$$= 8 - \frac{8}{\infty}$$

$$= 8 - 0$$

$$= 8$$

By limits theorem,

$$8n^2 - 8 \in O(n^2)$$