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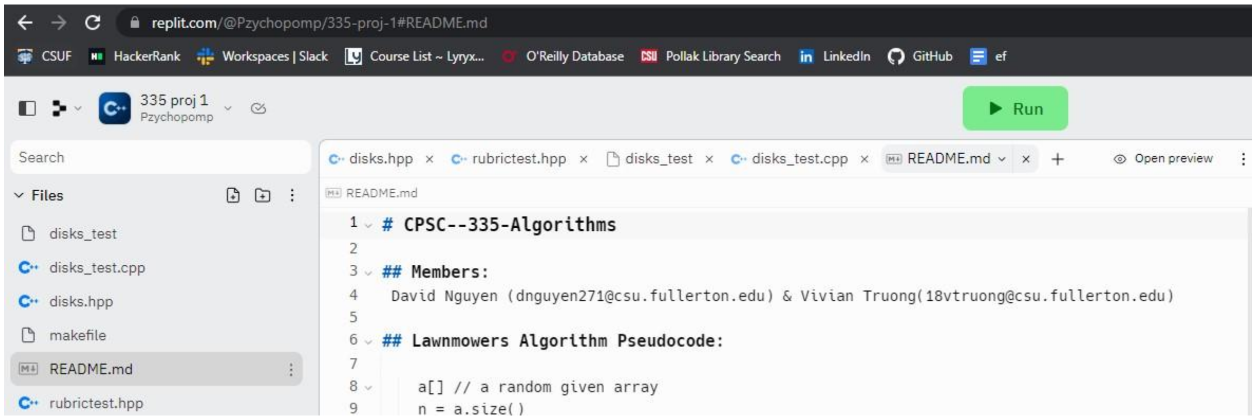
CPSC 335 Project 1 Submission PDF

2. The following is a screenshot inside Replit, the editor used for this project:



```
# CPSC--335-Algorithms

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## Lawnmowers Algorithm Pseudocode:

    a[] // a random given array
    n = a.size()
```
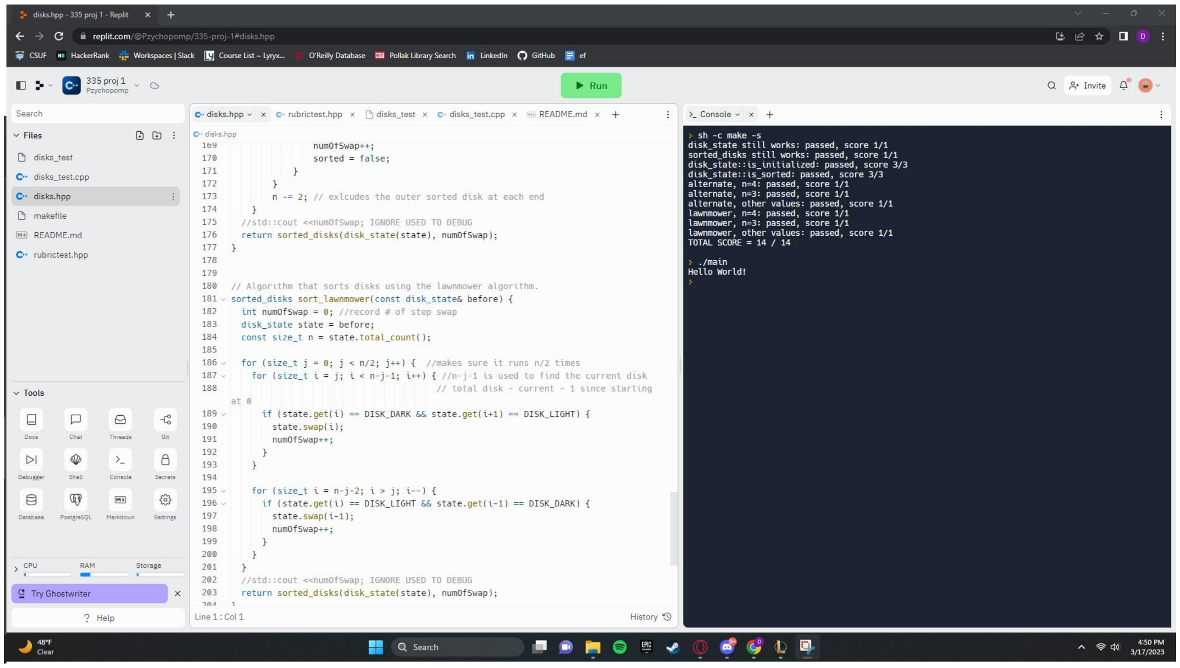

3. Screenshot of execution:



```
                numOfSwap++;
                sorted = false;
            }
        }
        n -= 2; // exlcudes the outer sorted disk at each end
    }
  //std::cout <<numOfSwap; IGNORE USED TO DEBUG
  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; //record # of step swap
  disk_state state = before;
  const size_t n = state.total_count();

  for (size_t j = 0; j < n/2; j++) {  //makes sure it runs n/2 times
    for (size_t i = j; i < n-j-1; i++) { //n-j-1 is used to find the current disk
                                          // total disk - current - 1 since starting
at 0
      if (state.get(i) == DISK_DARK && state.get(i+1) == DISK_LIGHT) {
        state.swap(i);
        numOfSwap++;
      }
    }

    for (size_t i = n-j-2; i > j; i--) {
      if (state.get(i) == DISK_LIGHT && state.get(i-1) == DISK_DARK) {
        state.swap(i-1);
        numOfSwap++;
      }
    }
  }
  //std::cout <<numOfSwap; IGNORE USED TO DEBUG
  return sorted_disks(disk_state(state), numOfSwap);
```

```
> sh -c make -s
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

> ./main
Hello World!
>
```

4. Step count and efficiency

Lawnmowers Algorithm:

Pseudocode:

```
a[] // a random given array
n = a.size()

for j = 0 to n/2 do:          // make sure it runs n/2 times    **n/2+1 times**
  for i = 1 to n-1 do:        // move from left to right        **n-1 times**
    if (a[i] == black && a[i+1] != black):        // check for swappable elements        **3tu**
      swap;

  for j = n-1 down to 1 do:  // move from right to left
    if(a[j] == white && a[j-1] != white): // check for swappable elements   **3tu**
       swap;
```

Step Count: 3(n^2-n)/2 + 3n-3.

Time complexity: O(n^2)

Alternate Algorithm Pseudocode:

Pseudocode:

```
a[] // a random given array
n = a.size()
bool sorted
while(!sorted) do:          **n-1 times**
  sorted = true
  for i = 1 to n-1 do:  // move from left to right      n-1-1+1 = **n-1 times**
    if (a[i] == black && a[i+1] != black): // check for swappable elements  **3tu**
      swap;
    sorted = false;

  for i = 2 to n-2 do: // check the second left to second right disc  n-2-2+1 = **n-3 times**
     if (a[i] == black && a[i+1] != black): // check for swappable elements **3tu**
      swap;
     sorted = false;
```

Step Count: 2n^2 - 2n

Time complexity: O(n^2)

5. Time Complexity

Lawnmowers Algorithm:

Step Count = OuterFLoop * InnerLoop1 * InnerLoop2
OuterFLoop = n/2

InnerLoop1 = OuterFLoop * IL1runs
IL1runs = n-1
InnerLoop1 = n*n-1

InnerLoop2 = OuterFLoop * IL2runs
IL2runs = n-1
InnerLoop2 = n*n-1

Step Count = (n/2) * (n*n-1) * (n*n-1) →
(n/2) * 2n * (n-1) →
(n/2)*(2n^2-2n) →
(n/2) * n * (2n-2) →
n*(2n-2) → **2n^2-2n**

As n → Infinity, 2n^2-2n will approach 2n^2, meaning this algorithm performs at roughly O(n^2) as a time complexity

Alternate Algorithm:

Step Count = countInWhile * #ofWLoop
#ofWLoop = n-1
countInWhile = 1 + FirstLoop + SecondLoop

FirstLoop = countInLoop1 * #ofFLoop1
countInLoop1 = 3
#ofFLoop1 = n-1
FirstLoop = 3(n-1)

SecondLoop = countInLoop2 * #ofFLoop2
countInLoop2 = 3
#ofFLoop2 = n-3
SecondLoop = 3(n-3)

countInWhile = n-1 + FirstLoop + SecondLoop
Step Count = (n-1)*3(n-1) + (n-3)*3(n-3) → 9n^2-36n+27

As $n \to$ Infinity, $9n^2-36n+27$ will approach $9n^2$, meaning the Alternate algorithm has a time complexity of $O(n^2)$