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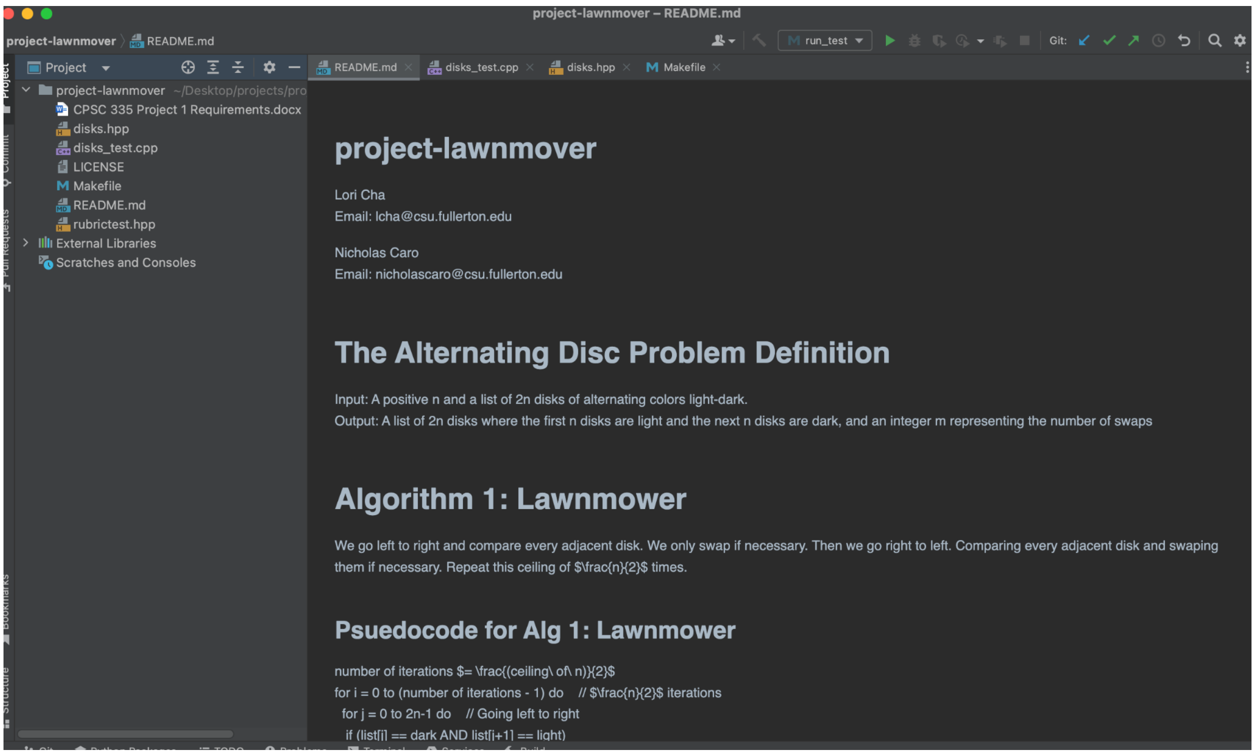
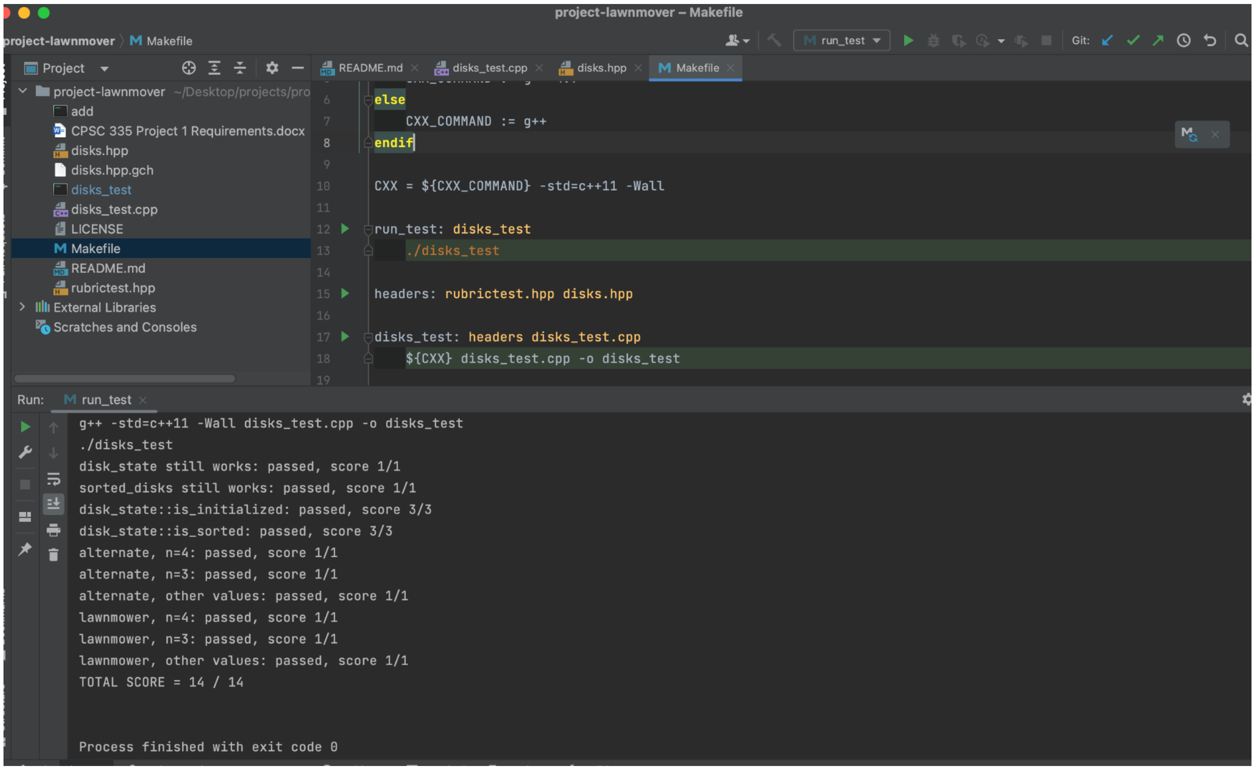
Project 1: Alternating Disks Problem

2. A full-screen screenshot, inside Tuffix, showing the Atom editor or the editor you used, with your group member names shown clearly as below. One way to make your names appear in Atom is to simply open your README.md.



3. A full-screen screenshot showing your code compiling and executing.



4. Two Pseudocode Listings, for the two algorithms and their step count

Psuedocode for Alg 1: Lawnmower

number of iterations $= \frac{(ceiling\ of\ n)}{2}$

for i = 0 to (number of iterations - 1) do // $\frac{n}{2}$ iterations

  for j = 0 to 2n-1 do // Going left to right

    if (list[j] == dark AND list[j+1] == light)

      Swap them

  end for

  for j = 2n-1 to j = 0 do // Going back right to left

    if (list[j-1] == dark AND list[j] == light)

      Swap them

  end for

end for

Step Count

$$
\begin{aligned}
S.C. &= \frac{n}{2}(2n-1(2+\max(0,1))+2n-1(2+\max(0,1))) \\
&= \frac{n}{2}(2n-1(2+1))+2n-1(2+1)) \\
&= \frac{n}{2}(2n-1(3))+2n-1(3)) \\
&= \frac{n}{2}((6n-3)+(6n-3)) \\
&= \frac{n}{2}(12n-6) \\
&= 6n^2-3n
\end{aligned}
$$

Psuedocode for Alg 2

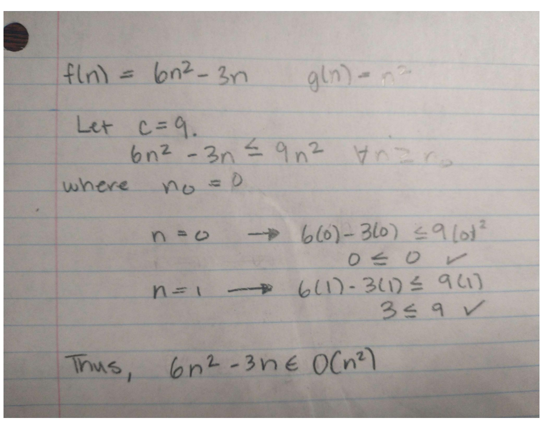
```
number of iterations = n + 1
for i = 0 to (# of iterations - 1) do
  if i is even do
    for j = 0 to length(list) - 1 step 2 do
      if (list[j] == dark AND list[j+1] == light])
        Swap them
    end for

  else do
    for j = 1 to length(list) - 2 step 2 do
      if (list[j] == dark AND list[j+1] == light)
        Swap them
    end for
end for
```

Step Count

$$
\begin{aligned}
S.C. &= n(1+\max(\tfrac{n-1}{2}(2+1), \tfrac{n-2}{2}(2+1)) \\
&= n(1+(\tfrac{n-1}{2}(3)) \\
&= n(1+(\tfrac{3}{2}(n-1)) \\
&= n+\tfrac{3}{2}n^2-\tfrac{3}{2}n \\
&= \tfrac{3}{2}n^2-\tfrac{1}{2}n
\end{aligned}
$$

5. A brief proof argument for the time complexity of your two algorithms
For Alg 1:



$f(n) = 6n^2 - 3n$ $g(n) = n^2$

Let $c = 9$.

$6n^2 - 3n \leq 9n^2 \quad \forall n \geq n_0$

where $n_0 = 0$

$n = 0 \rightarrow 6(0) - 3(0) \leq 9(0)^2$

$0 \leq 0$ ✓

$n = 1 \rightarrow 6(1) - 3(1) \leq 9(1)$

$3 \leq 9$ ✓

Thus, $6n^2 - 3n \in O(n^2)$

Efficiency Class Using Limit Theorem

$\lim_{n\to\infty} \frac{6n^2-3n}{n^2} = 6$

Since $6 \geq 0$ and 6 is a constant, the Limit Theorem tells us that $6n^2 - 3n \in O(n^2)$.
Thus, this implementation of this algorithm is $O(n^2)$.

For Alg 2:

$f(n) = \frac{3}{2}n^2 - \frac{1}{2}n \qquad g(n) = n^2$

Let $c = 2$ and $n_0 = 0$

Notice, $\frac{3}{2}n^2 - \frac{1}{2}n \leq 2n^2 \quad \forall n \geq n_0$

$n = 0 \longrightarrow \frac{3}{2}(0) - \frac{1}{2}(0) \leq 2(0)^2$

$0 \leq 0$

$n = 1 \longrightarrow \frac{3}{2}(1)^2 - \frac{1}{2}(1) \leq 2(1)^2$

$1 \leq 2$ ✓

Thus, $\frac{3}{2}n^2 - \frac{1}{2}n \in O(n^2)$

Efficiency Class Using Limit Theorem

$\lim_{n\to\infty} \frac{\frac{3}{2}n^2 - \frac{1}{2}n}{n^2} = \frac{3}{2}$

Since $\frac{3}{2} \geq 0$ and $\frac{3}{2}$ is a constant, the Limit Theorem tells us that $\frac{3}{2}n^2 - \frac{1}{2}n \in O(n^2)$

Thus, this implementation of this algorithm is $O(n^2)$.