Project Lawnmower

CPSC 335 Section 08: Algorithm Engineering

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Alternate Algorithm

Pseudocode

```
sorted_disk sort_alternate(const disk_state& before) {
int number_of_swaps = 0
disk_state state = before

for int i = 0 to state total count do
    for int j = i to state total count - 1 do
        if state.get(j) = disk_dark and state.get(j + 1) = disk_light
            swap(j)
            number of swaps += 1
        end if
    end for
end for

return sorted_disk()
}
```

Alternate Algorithm

Step count

num of swaps = 0 → 1 tu
disk state = before → 1 tu

```
for i = 0 to n do
    for j = i to n-1 do
        if get(j) = disk_dark and get(j+1) = disk_light      → 3 tu
            swap                                             → 1 tu
            num of swaps += 1                                → 1 tu
return sorted disk
```

$$\sum_{i=0}^{n} \sum_{j=i}^{n-1} 5 \;\rightarrow\; \sum_{j=1}^{n-1} 5 - \sum_{j=1}^{i-1} 5 \;\Rightarrow\; \sum_{j=1}^{n-1} 5 - \sum_{j=1}^{i-1} 5$$

$$5(n-1)-(i-1) \rightarrow 5(n-1-i+1) \Rightarrow 5n-5i$$

$$\sum_{i=0}^{n} 5n-5i$$

$$\sum_{i=0}^{n} 5n - \sum_{i=0}^{n} 5i \;\rightarrow\; 5\left(\frac{n(n+1)}{2}\right) \Rightarrow \frac{5n^2+5n}{2}$$

$$5n^2 - \frac{5n^2}{2} + \frac{5n}{2} + 2$$

Alternate Algorithm

Proof by definition

$5n^2 - \frac{5n^2}{2} + \frac{5n}{2} + 2 \in O(n^2)$

$f(n) = 5n^2 - \frac{5n^2}{2} + \frac{5n}{2} + 2$, $g(n) = n^2$

By def:

$5n^2 - \frac{5n^2}{2} + \frac{5n}{2} + 2 \leq c(n^2)$

$c = 20 \quad n_0 = 1$

$5n^2 - \frac{5n^2}{2} + \frac{5n}{2} + 2 \leq 20n^2$

$5 - \frac{5}{2} + \frac{5}{2} + 2 \leq 20$

$7 \leq 20$ Prove that $5n^2 - \frac{5n^2}{2} + \frac{5n}{2} + 2 \in O(n^2)$

Proof by limit theorem

$\underbrace{5n^2 - \frac{5n^2}{2} + \frac{5n}{2} + 2}_{f(n)} \in O(\underbrace{n^2}_{g(n)})$

$\lim_{n \to \infty} \frac{5n^2 - \frac{5n^2}{2} + \frac{5n}{2} + 2}{n^2}$ $\Rightarrow$ (l'hopital) $\lim_{n \to \infty} \frac{10n - \frac{10n}{2} + \frac{5}{2} + 0}{2n}$

$\Rightarrow \lim_{n \to \infty} \frac{5n + \frac{5}{2}}{2n} \Rightarrow \lim_{n \to \infty} \frac{5n + 0}{2}$

$\lim_{n \to \infty} \frac{5}{0} \Rightarrow 0$

Hence $5n^2 - \frac{5n^2}{2} + \frac{5n}{2} + 2 \in O(n^2)$

Lawnmower Algorithm

Pseudocode

```
sorted_disk sort_lawnmower(const disk_state& before) {
int number_of_swaps = 0
disk_state state = before

for int i = 0 to state light count do
   for int j = i to state light count - 1 do
      if state.get(j) = disk_dark and state.get(j + 1) = disk_light
         swap(j)
         number of swaps += 1
      end if

   end for

   for int k = state total count - 1 to 0 do
      if state.get(k) = disk_light and state.get(k-1) = disk_dark
         state.swap(k - 1)
         number of swaps += 1
    end for

end for

return sorted_disk()
}
```

Lawnmower Algorithm

Step count

num of swaps = 0 → 1 tu
disk state = before → 1 tu
} 2

```
for i = 0 to n do
  for j = i to n-1 do
    if get(j) = disk_dark and get(j+1) = disk_light      (3 tu)
      swap                                              (1 tu)
      num of swaps += 1                                 (1 tu)

for k = n-1 to n do                                     (3 tu)
  if get(k) = disk_light and get(k-1) = disk dark
    swap(k-1)                                           (2 tu)
    num of swaps += 1                                   (1 tu)
return sorted disk
```

$$\sum_{i=0}^{n}\sum_{j=1}^{n-1} \cdot 5 \;+\; \sum_{i=0}^{n}\sum_{k=n-1}^{n} \cdot 6 \rightarrow \sum_{i=0}^{n} \cdot \sum_{k=1}^{n} - \sum_{k=1}^{n-1} \cdot 6$$

$$\sum_{i=0}^{n} \cdot \sum_{j=1}^{n-1} 5 - \sum_{j=1}^{i=1} 5$$

$$\sum_{i=0}^{n} n - \sum_{k=1}^{n-1} \cdot 6$$

$$\sum_{i=0}^{n} 5n - 5i$$

$$\sum_{i=0}^{n} n - 6n - 1 \Rightarrow \sum_{i=0}^{n} 5n - 1$$

$$\sum_{i=0}^{n} 5n - \sum_{i=0}^{n} 5i \rightarrow \cancel{5n^2} - \frac{5n^2}{2} + \frac{5n}{2} + 2 + \cancel{5n^2} - n$$

$$\Rightarrow -\frac{5n^2}{2} + \frac{5n}{2} - n + 2 + 2$$

$$\Rightarrow -\frac{5n^2}{2} + \frac{5n}{2} - n + 4$$

Lawnmower Algorithm

Proof by definition

$\underbrace{\frac{-5n^2}{2} + \frac{5n}{2}}_{f(n)} - n + 4 \in \underbrace{O(n^2)}_{g(n)}$

By def:

$\frac{-5n^2}{2} + \frac{5n}{2} - n + 4 \leq c(n^2)$

$c = 15, \; n_0 = 1$

$\frac{-5n^2}{2} + \frac{5n}{2} - n + 4 \leq 15n^2 \quad n_0 = 1$

$-5 \neq 5 - 1 + 4 \leq 15$

$3 \leq 15$

Prove that $\frac{-5n^2}{2} + \frac{5n}{2} - n + 4 \in O(n^2)$

Proof by limit theorem

$\underbrace{\frac{-5n^2}{2} + \frac{5n}{2}}_{f(n)} - n + 4 \in \underbrace{O(n^2)}_{g(n)}$

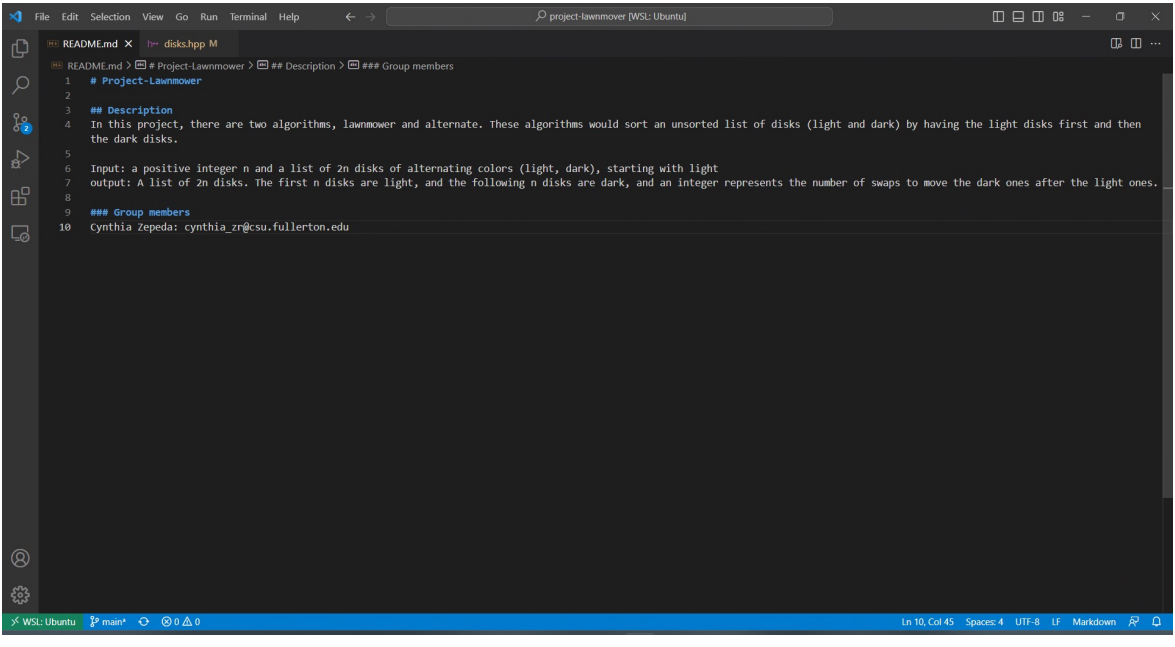
$\lim_{n \to \infty} \frac{\frac{-5n^2}{2} + \frac{5n}{2} - n + 4}{n^2} \Rightarrow \overset{\text{l'hopital}}{\lim_{n \to \infty}} \frac{\frac{-10n}{2} + \frac{5}{2} - 1 + 0}{2n}$

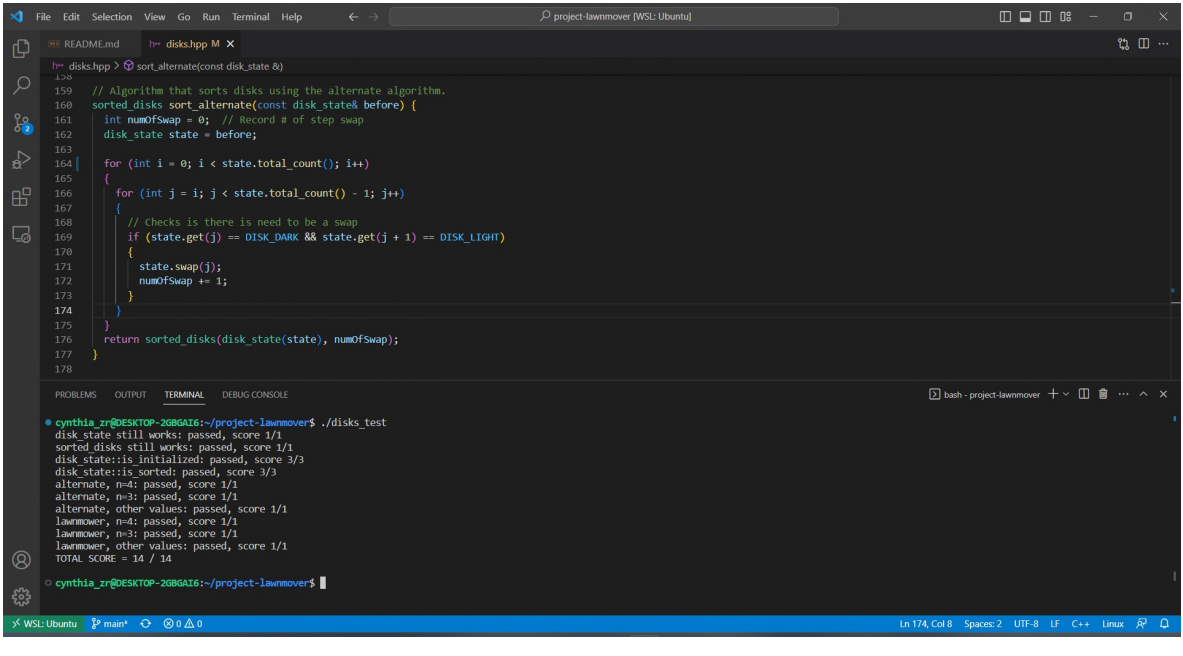
$\Rightarrow \lim_{n \to \infty} \frac{5n + \frac{5}{2} - 1}{2n} \rightarrow \overset{\text{l'hopital}}{\lim_{n \to \infty}} \frac{5n + 0}{2}$

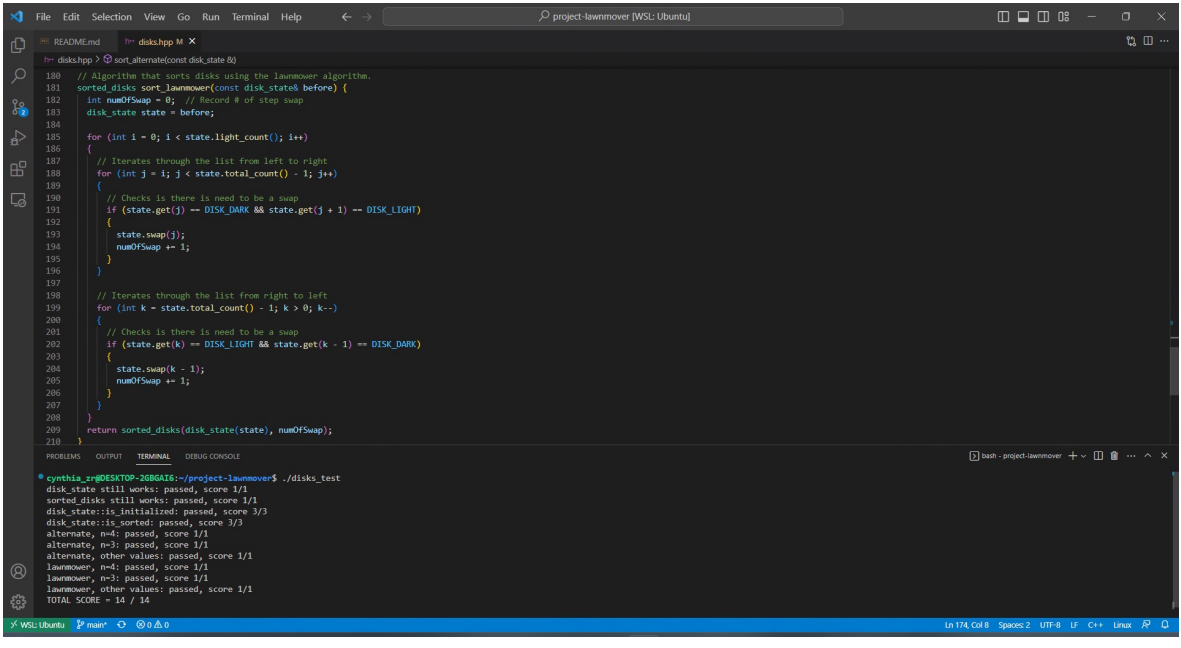
$\Rightarrow \lim_{n \to \infty} \frac{5}{0}$

Hence $\frac{-5n^2}{2} + \frac{5n}{2} - n + 4 \in O(n^2)$

Screenshot


File Edit Selection View Go Run Terminal Help
project-lawnmover [WSL: Ubuntu]
README.md
disks.hpp M
README.md > # Project-Lawnmower > ## Description > ### Group members
Project-Lawnmower
Description
In this project, there are two algorithms, lawnmower and alternate. These algorithms would sort an unsorted list of disks (light and dark) by having the light disks first and then the dark disks.
Input: a positive integer n and a list of 2n disks of alternating colors (light, dark), starting with light
output: A list of 2n disks. The first n disks are light, and the following n disks are dark, and an integer represents the number of swaps to move the dark ones after the light ones.
Group members
Cynthia Zepeda: cynthia_zr@csu.fullerton.edu
WSL: Ubuntu
main*
Ln 10, Col 45
Spaces: 4
UTF-8
LF
Markdown


File Edit Selection View Go Run Terminal Help
project-lawnmover [WSL: Ubuntu]
README.md
disks.hpp M
disks.hpp > sort_alternate(const disk_state &)
// Algorithm that sorts disks using the alternate algorithm.
sorted_disks sort_alternate(const disk_state& before) {
int numOfSwap = 0; // Record # of step swap
disk_state state = before;
for (int i = 0; i < state.total_count(); i++)
{
for (int j = i; j < state.total_count() - 1; j++)
{
// Checks is there is need to be a swap
if (state.get(j) == DISK_DARK && state.get(j + 1) == DISK_LIGHT)
{
state.swap(j);
numOfSwap += 1;
}
}
}
return sorted_disks(disk_state(state), numOfSwap);
}
PROBLEMS
OUTPUT
TERMINAL
DEBUG CONSOLE
bash - project-lawnmover
cynthia_zr@DESKTOP-2GBGAI6:~/project-lawnmover$ ./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
cynthia_zr@DESKTOP-2GBGAI6:~/project-lawnmover$
WSL: Ubuntu
main*
Ln 174, Col 8
Spaces: 2
UTF-8
LF
C++
Linux


File Edit Selection View Go Run Terminal Help
project-lawnmover [WSL: Ubuntu]
README.md
disks.hpp M
disks.hpp > sort_alternate(const disk_state &)
// 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;
for (int i = 0; i < state.light_count(); i++)
{
// Iterates through the list from left to right
for (int j = i; j < state.total_count() - 1; j++)
{
// Checks is there is need to be a swap
if (state.get(j) == DISK_DARK && state.get(j + 1) == DISK_LIGHT)
{
state.swap(j);
numOfSwap += 1;
}
}
// Iterates through the list from right to left
for (int k = state.total_count() - 1; k > 0; k--)
{
// Checks is there is need to be a swap
if (state.get(k) == DISK_LIGHT && state.get(k - 1) == DISK_DARK)
{
state.swap(k - 1);
numOfSwap += 1;
}
}
}
return sorted_disks(disk_state(state), numOfSwap);
}
PROBLEMS OUTPUT TERMINAL DEBUG CONSOLE
bash - project-lawnmover
cynthia_zr@DESKTOP-2GBGAI6:~/project-lawnmover$ ./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
WSL: Ubuntu
main*
Ln 174, Col 8
Spaces: 2
UTF-8
LF
C++
Linux