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CPSC 335 Fall 2020

Project 1: Alternating Disks

The screenshot displays a development environment with the Atom text editor and a terminal window. The Atom editor is open to a file named `README.md` in the project `~/Desktop/project-1-alternating-disks-csuf-335-01-tuan-ngo`. The file content is as follows:

```
1 # 335-Project-1
2 Alternating disks
3
4 Group members:
5
6 Tuan Ngo nat1994@csu.fullerton.edu
7
```

The terminal window, titled `Terminal - student@tuffix-vm...`, shows the prompt `student@tuffix-vm:~/Desktop/project-1-alternating-disks-csuf-335-01-tuan-ngo$`. The background of the terminal features a green and yellow binary code pattern.

```

student@tuffix-vm: ~/Desktop/project-1-alternating-disks-csuf-335-01-tuan-ngo$ ls
disks.hpp  disks_test.cpp  LICENSE  Makefile  README.md  rubric_test.hpp
student@tuffix-vm: ~/Desktop/project-1-alternating-disks-csuf-335-01-tuan-ngo$ 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 1/1
disk state::is sorted: passed, score 1/1
alternate, n=3: passed, score 1/1
alternate, n=4: passed, score 1/1
alternate, other values: passed, score 1/1
lawnmower, n=3: passed, score 1/1
lawnmower, n=4: passed, score 1/1
lawnmower, other values: passed, score 1/1
TOTAL SCORE = 10 / 10
student@tuffix-vm: ~/Desktop/project-1-alternating-disks-csuf-335-01-tuan-ngo$

# 335-Project-1
Alternating disks

Group members:
Tuan Ngo nat1994@csu.fullerton.edu

```

Pseudocode:

1. sort_alternate

```

sorted_disks sorted_disks sort_alternate(const disk_state& before):
    count = 0 // 1 t.u.
    tmp_disks = before // 1 t.u.
    for i = 0 to size(tmp_disks) - 1 do: //analysis later
        for j = i + 1 to size(tmp_disks) - 1 do: //analysis later
            if tmp_disks[j - 1]==DISK_LIGHT && tmp_disks[j]==DISK_DARK : // 3 t.u.
                then:
                    tmp_disks.swap(j - 1) // Professor told 3 t.u.
                    count++ // 1 t.u.
            endif
        endfor
    endfor
    return sorted_disks(tmp_disks, count)

```

analysis:

assume:

size(Disks) = n

return does not count time unit

lookup array/vector/list does not count time units

$$\text{s.c} = 2 + \sum_{i=0}^{n-1} \sum_{j=i+1}^{n-1} (3 + \max(0, 4))$$

$$\text{s.c} = 2 + \sum_{i=0}^{n-1} \sum_{j=i+1}^{n-1} 7$$

$$\text{s.c} = 2 + \sum_{i=0}^{n-1} \sum_{j=i}^{n-2} 7$$

$$\begin{aligned} \text{Calculate: } \sum_{j=i}^{n-2} 7 &= \sum_{j=1}^{n-2} 7 - \sum_{j=1}^{i-1} 7 \\ &= 7(n-2) - 7(i-1) \\ &= 7(n-2-i+1) \\ &= 7(n-i-1) \end{aligned}$$

$$\begin{aligned} \text{s.c} &= 2 + \sum_{i=0}^{n-1} 7(n-i-1) \\ &= 2 + \sum_{i=0}^{n-1} 7(n-1) - \sum_{i=0}^{n-1} 7i \\ &= 2 + 7(n-1)(n-1) - 7 \frac{n(n-1)}{2} \\ &= 2 + 7(n^2 - 2n + 1) - \frac{7n^2 - 7n}{2} \\ &= (4 + 14n^2 - 28n + 14 - 7n^2 + 7) / 2 \\ \text{s.c} &= (7n^2 - 28n + 25) / 2 \end{aligned}$$

Time complexity: $O(n^2)$

Prove:

Show $((7n^2 - 28n + 25) / 2)$ belongs to $O(n^2)$

Find $c \geq 0$ and $n_0 \geq 0$ such that $4n^2 - 2 \leq c * n^2$ with all $n \geq n_0$

Choose $c = 60/2 = 30$

$$(7n^2 - 28n + 25) / 2 \leq 60n^2 / 2$$

$$7n^2 - 28n + 25 \leq 60n^2$$

$$7n^2 - 28n + 25 \leq 7n^2 + 28n^2 + 25n^2$$

$$7n^2 - 7n^2 + 28n^2 + 28n + 25n^2 - 25 \geq 0$$

$$n \geq 1 \text{ and } n_0 = 1$$

2. sort_lawnmower

```

sorted_disks sort_lawnmower(const disk_state& before):
    tmp_disk = before; // 1 t.u.
    count = 0 // 1 t.u.
    for i = 0 to (size(Disks) / 2 ) - 1 do: //Analysis later
        for j = 1 + i to size(Disks) - 1 do: //Analysis later
            if tmp_disks[j-1] == DISK_LIGHT && tmp_disks[j] == DISK_DARK: // 3 t.u.
                then:
                    tmp_disks.swap(j - 1) // Professor told 3 t.u.
                    count++; // 1 t.u.

                endthen
            endif
        endfor
        for k = size(Disks) - 1 - i down to 1 do:
            if tmp_disks[k] == DISK_DARK && tmp_disks[k - 1] == DISK_LIGHT: //3 t.u.
                then:
                    tmp_disks.swap(k - 1 ) // Professor told 3 t.u.
                    count++; // 1 t.u.

                endthen
            endif
        endfor
    endfor
    return sorted_disks(tmp_disks,count)

```

analysis:

assume:

size(Disks) = n

return does not count time unit

lookup array/vector/list does not count time units

$$s.c = 2 + \sum_{i=0}^{\frac{n}{2}-1} (\sum_{j=i+1}^{n-1} (3 + \max(0,4)) + \sum_{k=1}^{n-1} (3 + \max(0,4)))$$

$$s.c = 2 + \sum_{i=0}^{\frac{n}{2}-1} \sum_{j=i+1}^{n-1} (3 + \max(0,4)) + \sum_{i=0}^{\frac{n}{2}-1} \sum_{k=1}^{n-1-i} (3 + \max(0,4))$$

$$\begin{aligned}
s.c &= 2 + \sum_{i=0}^{\frac{n}{2}-1} \sum_{j=i}^n 7 + \sum_{i=0}^{\frac{n}{2}-1} \sum_{k=1}^{n-1-i} 7 \\
s.c &= 2 + \sum_{i=0}^{\frac{n}{2}-1} (7(n-i+1)) + \sum_{i=0}^{\frac{n}{2}-1} \sum_{k=i}^n 7 \\
s.c &= 2 + \sum_{i=0}^{\frac{n}{2}-1} (7n+7) - \sum_{i=0}^{\frac{n}{2}-1} (7i) + \sum_{i=0}^{\frac{n}{2}-1} (7n+7) - \sum_{i=0}^{\frac{n}{2}-1} (7i) \\
s.c &= 2 + [(7n+7) * (\frac{n}{2})] - (7(n^2-2n)/8) + ((7n+7) * (\frac{n}{2})) - (7(n^2-2n)/8) \\
s.c &= 2 + (7n^2+7n) - (7n^2-14n)/4 \\
s.c &= (8+28n^2+28n-7n^2+14n)/4 \\
s.c &= (21n^2+42n+8)/4
\end{aligned}$$

Time complexity: $O(n^2)$

Prove:

Show $((21n^2 + 42n + 8)/4)$ belongs to $O(n^2)$

Find $c \geq 0$ and $n_0 \geq 0$ such that $6n^2 + 12n + 2 \leq c * n^2$ with all $n \geq n_0$

Choose $c = 71/4$

$$(21n^2 + 42n + 8)/4 \leq 71n^2/4$$

$$21n^2 + 42n + 8 \leq 21n^2 + 42n^2 + 8n^2$$

$$21n^2 - 6n^2 + 42n^2 - 42n + 8n^2 - 8 \geq 0$$

$$n \geq 1 \text{ and } n_0 = 1$$