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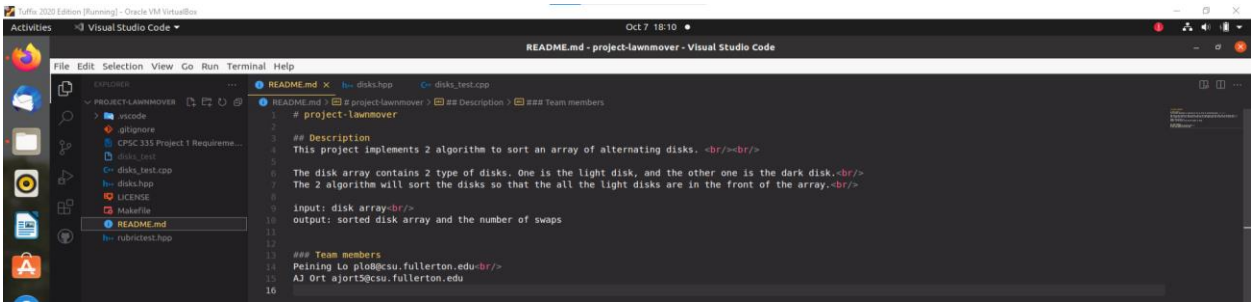
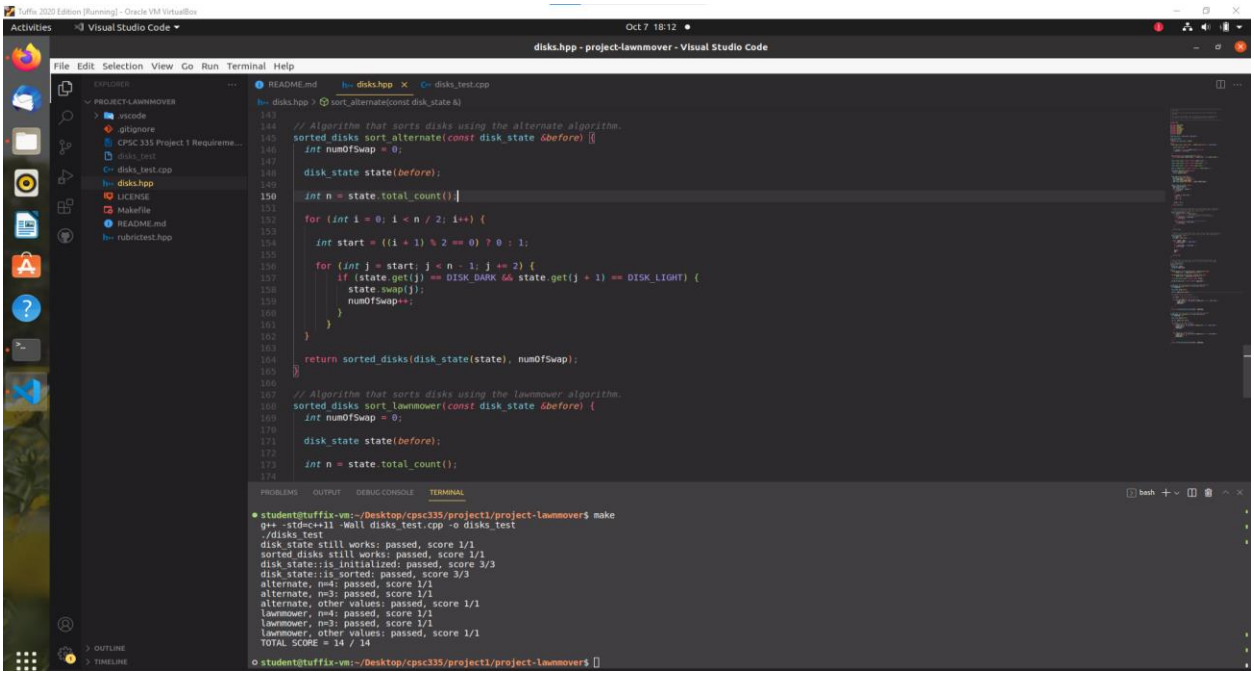
Project 1





Pseudocode

Lawnmower

```
function lawnmower(diskArr) {
	numSwap = 0
	newDiskArr = diskArr
	n = total number of disks

	for(i = 0 to n/4 - 1) do
		for(j = 0 to n-2) do
			if(newDiskArr[j] is dark AND newDiskArr[j+1] is light)
				swap newDiskArr[j] and newDiskArr[j+1]
				numSwap++
				endif
			endfor
		for(j = n-1 to 1) step down, do
			if(newDiskArr[j] is light AND newDiskArr[j-1] is dark)
				swap newDiskArr[j] and newDiskArr[j-1]
				numSwap++
				endif
			endfor
		endfor

	return (newDiskArr, numSwap)
}
```

Alternate

```
function alternate(diskArr) {
	numSwap = 0
	newDiskArr = diskArr
	n = total number of disks

	for(i = 0 to n/2 - 1)
		start = 0
		if( (i+1) % 2 == 0)
			start = 0
			endif
		else
			start = 1
			endelse

		for(j = start to n-2) step 2
			if(newDiskArr[j] is dark AND newDiskArr[j+1] is light
				swap newDiskArr[j] and newDiskArr[j+1]
				numSwap++
				endif
			endfor
		endfor

	return (newDiskArr, numSwap)
}
```

Step Count

Lawnmower

```
function lawnmower(diskArr) {
	numSwap = 0                                                    1
	newDiskArr = diskArr                                           1
	n = total number of disks                                      1

	for(i = 0 to n/4 - 1) do
		for(j = 0 to n-2) do
			if(newDiskArr[j] is dark AND newDiskArr[j+1] is light)     5
				swap newDiskArr[j] and newDiskArr[j+1]         1
				numSwap++                                      1
				endif
			endfor
		for(j = n-1 to 1) step down, do
			if(newDiskArr[j] is light AND newDiskArr[j-1] is dark)     5
				swap newDiskArr[j] and newDiskArr[j-1]         1
				numSwap++                                      1
				endif
			endfor
		endfor

	return (newDiskArr, numSwap)
}
```

```
for(j = 0 to n-2),
```

$$sc = \sum_{0}^{n-2} 7 = \sum_{1}^{n-1} 7 = 7n - 7$$

```
for(j = n-1 to 1) step down
```

$$sc = \sum_{1}^{n-1} 7 = 7n - 7$$

$$7n - 7 + (7n - 7) = 14n - 14$$

```
for(i = 0 to n/4 - 1)
```

$$sc = \sum_{0}^{\frac{n}{4}-1} (14n - 14) = \sum_{1}^{\frac{n}{4}} (14n - 14) = (14n - 14)\frac{n}{4} = \frac{7}{2}n^2 - \frac{7}{2}n$$

$$Total\ sc = \frac{7}{2}n^2 - \frac{7}{2}n + 3$$

Alternate

```
function alternate(diskArr) {
	numSwap = 0                                                    1
	newDiskArr = diskArr                                           1
	n = total number of disks                                      1

	for(i = 0 to n/2 - 1)
		start = 0                                              1
		if( (i+1) % 2 == 0)                                    3
			start = 0                                  1
			endif
		else
			start = 1                                  1
			endelse

		for(j = start to n-2) step 2
			if(newDiskArr[j] is dark AND newDiskArr[j+1] is light      5
				swap newDiskArr[j] and newDiskArr[j+1]     1
				numSwap++                                  1
				endif
			endfor
		endfor

	return (newDiskArr, numSwap)
}
```

```
for(j = start to n-2) step 2
```

in this case, start can only be 0 OR 1, use 0 because we are taking the upper bound

$$\sum_{0}^{n-2} 7\ step2 = \sum_{1}^{n-1} 7\ step2 = \sum_{1}^{\frac{n-1}{2}} 7 = \frac{7}{2}n - \frac{7}{2}$$

$$\frac{7}{2}n - \frac{7}{2} + 5 = \frac{7}{2}n + \frac{3}{2}$$

```
for(i = 0 to n/2 - 1)
```

$$\sum_{0}^{\frac{n}{2}-1} (\frac{7}{2}n + \frac{3}{2}) = \sum_{1}^{\frac{n}{2}} (\frac{7}{2}n + \frac{3}{2}) = \frac{7}{2}n + \frac{3}{2}\left(\frac{n}{2}\right) = \frac{7}{4}n^2 + \frac{3}{4}n$$

$$Total\ sc = \frac{7}{4}n^2 + \frac{3}{4}n + 3$$

Analysis

Lawnmower

$$Total\ sc = \frac{7}{2}n^2 - \frac{7}{2}n + 3\ \in O(n^2)$$

Proof by definition:

$f(n) = \frac{7}{2}n^2 - \frac{7}{2}n + 3$

$g(n) = n^2$

$f(n) \leq c * g(n) \quad for\ n \geq\ n_0$

$c = \frac{7}{2} + \frac{7}{2} + 3 = 10$

$n_0 = 1$

$\frac{7}{2} - \frac{7}{2} + 3 = 3 \leq 10$

Proof by limit theorem:

$$L = \lim_{n\to\infty} \frac{f(n)}{g(n)} = \lim_{n\to\infty} \frac{\frac{7}{2}n^2 - \frac{7}{2}n + 3}{n^2} = \lim_{n\to\infty} \frac{(\frac{7}{2}n^2 - \frac{7}{2}n + 3)'}{(n^2)'} = \lim_{n\to\infty} \frac{\frac{7}{2}n - \frac{7}{2}}{n} = \lim_{n\to\infty} \frac{\frac{7}{2}}{1} = \frac{7}{2}$$

$L = \frac{7}{2} \geq 0\ and\ is\ a\ constant$

Alternate

$$Total\ sc = \frac{7}{4}n^2 + \frac{3}{4}n + 3$$

Proof by definition:

$f(n) = \frac{7}{4}n^2 + \frac{3}{4}n + 3$

$g(n) = n^2$

$f(n) \leq c * g(n) \quad for\ n \geq\ n_0$

$c = \frac{7}{4} + \frac{3}{4} + 3 = \frac{11}{2}$

$n_0 = 1$

$\frac{7}{4} + \frac{7}{4} + 3 = \frac{11}{2} \leq \frac{11}{2}$

Proof by limit theorem:

$L = \lim_{n\to\infty} \frac{f(n)}{g(n)} = \lim_{n\to\infty} \frac{\frac{7}{4}n^2 + \frac{3}{4}n + 3}{n^2} = \lim_{n\to\infty} \frac{(\frac{7}{4}n^2 + \frac{3}{4}n + 3)'}{(n^2)'} = \lim_{n\to\infty} \frac{\frac{7}{4}n + \frac{7}{4}}{n} = \lim_{n\to\infty} \frac{\frac{7}{4}}{1} = \frac{7}{4}$

$L = \frac{7}{4} \geq 0\ and\ is\ a\ constant$