```
sorted_disks sort_lawnmower(const disk_state& before) {

        sorted_disks BLIN = before  //1
        Left_index_limit = 0  //1
        Right_index_limit = n - 2;  //1                          5  +
        j = 0; //used to traverse BLIN's disk vector  //1
        reverse = false;  //1

        for (i = 0; i < n/2; i++){ // n/2 steps *
                while(1) { // MAX_AMOUNT_while_coniterate(n) = n-1 steps *
                        if (Left_index_limit = = Righet_index_limit) { // 1 + max(3, 13, 12) = 14
                                BLIN.swap(index_of_disks[Left_index_limit],index_of_disks[Right_index_limit]) //1
                                BLIN.swap_counter++ //1                                  3
                                break //1
                        }else if (!reverse) {   // 1 + max(12, 0) = 13
                                if (BLIN.index_of_disks[j] = = DISK_DARK && BLIN.index_of_disks[j+1] = = DISK_LIGHT) { //3 + max(2,0) = 5
                                        BLIN.swap(index_of_disks[Left_index_limit],index_of_disks[Right_index_limit]) //1
                                        BLIN.swap_counter++ //1
                                }
                                if (j == Right_index_limit) {   1 + max(5,0) = 6             12

                                        Right_index_limit-- //1
                                        Left_index_limit++ //1
                                        reverse = true //1                      5
                                        j--  //1
                                        break  //1
                                }
                                j++ //1
                        }else {
                                if (BLIN.index_of_disks[j] = = DISK_DARK && BLIN.index_of_disks[j+1] = = DISK_LIGHT) { //3 + max(2,0) = 5
                                        BLIN.swap(index_of_disks[Left_index_limit],index_of_disks[Right_index_limit]) //1
                                        BLIN.swap_counter++ //1
                                }
                                if (j = = Left_index_limit) {  // 1 + max(5,0) = 6                  12
                                        Right_index_limit-- //1
                                        Left_index_limit++ //1
                                        reverse = false  //1                    5
                                        j++  //1
                                        break //1
                                }
                                j-- //1
                        }                                                          L'
                }
        }

        return BLIN object's sorted disks} //1
```

$5 + (n/2)(n-1)(14) + 1$

$(n/2)(14n-14)$

$5 + (7n^2 + 7n) + 1 = 7n^2 + 7n + 6$

Proof that

$g(n) = 7n^2 + 7n + 6$

$f(n) = n^2$

$g(n) \in O(f(n))$

$\equiv 7n^2 + 7n + 6 \in O(n^2)$

using limits (L'Hopital)

$\lim_{n\to\infty} \frac{g'(n)}{f'(n)} = L$, non-$-$ and constant

$\lim_{n\to\infty} \frac{\frac{d}{dn}(7n^2+7n+6)}{\frac{d}{dn}(n^2)} = \frac{\infty}{\infty}$

$\lim_{n\to\infty} \frac{14n+7}{2n}\ \frac{\infty}{\infty}$

$\lim_{n\to\infty} \frac{\frac{d}{dn}(14n+7)}{\frac{d}{dn}(2n)}$

$\lim_{n\to\infty} \frac{14}{2} = 7$

$\therefore 7n^2 + 7n + 6 \in O(n^2)$

```
sorted_disks sort_left_to_right(const disk_state& before) {

        sorted_disks BLIN = before   // 1 step

        for (i = 0; i < n/2; i++){ //n/2 steps ——— x
                for (size_t j = 0; j < n - 1; j++) { // n-1 steps ——— x ———
                        if (BLIN.index_of_disks[j] = = DISK_DARK && BLIN.index_of_disks[j+1] = = DISK_LIGHT){ //3   + max (2,0)
                                //DISCLAIMER: This just the idea, not syntactically correct.
                                BLIN.swap(index_of_disks[j],index_of_disks[j+1]) // 1 step
                                BLIN.swap_counter++    // 1 step
                        }
                }
        }
  return BLIN object's sorted disks // 1 step
}
```

$3+2=5$

$(n-1)(5) = 5n-5$

$\left(\frac{n}{2}\right)(5n-5) = \frac{5}{2}n^2 - \frac{5}{2}n$

$1 + \left(\frac{5n^2}{2} - \frac{5}{2}n\right) + 1$

$\frac{5}{2}n^2 - \frac{5}{2}n + 2$ (total steps)

Proving using L'Hopital that if $g(n) = O(f(n))$ the $\lim_{n\to\infty} \frac{g'(n)}{f'(n)} = L$ where L is a non-negative constant

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

$$\lim_{n\to\infty} \frac{\frac{d}{dn}\left(\frac{5}{2}n^2 - \frac{5}{2}n + 2\right)}{\frac{d}{dn}(n^2)} \Rightarrow \lim_{n\to\infty} \frac{\left(5n - \frac{5}{2}\right)}{2n} = \frac{\infty}{\infty}$$

$$\lim_{n\to\infty} \frac{\frac{d}{dn}\left(5n - \frac{5}{2}\right)}{\frac{d}{dn}(2n)} \Rightarrow \lim_{n\to\infty} \frac{5}{2} = \frac{5}{2}$$

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