«РГР» Increase Solved, Decrease Left

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**Task 1**. Insertion sort.

Manually execute insertion sort algorithm. Calculate total number of moves and total number of insertions (except trivial “insertions” which actually do nothing).

Case number 18.

**(18).** 44 77 6 0 33 66 8 88 99 11 4 22 2 55;

Consider case 0 (array 44, 77, 6, 0, 33, 66, 8, 88, 99, 11, 4, 22, 2, 55).

**Main loop iteration i=1:**

* Array before: 44, 77, 6, 0, 33, 66, 8, 88, 99, 11, 4, 22, 2, 55
* Current element: 77
* No movement required (since 77>44), so the array remains unchanged.

**Array after**: 44, 77, 6, 0, 33, 66, 8, 88, 99, 11, 4, 22, 2, 55

**Main loop iteration i=2:**

* Array before: 44, 77, 6, 0, 33, 66, 8, 88, 99, 11, 4, 22, 2, 55
* Current element: 6
* Move elements 77,44 to the right to make space.
* Moves: 2
* Insert 6 at the beginning.

**Array after**: 6, 44, 77, 0, 33, 66, 8, 88, 99, 11, 4, 22, 2, 55

**Main loop iteration i=3:**

* Array before: 6, 44, 77, 0, 33, 66, 8, 88, 99, 11, 4, 22, 2, 55
* Current element: 0
* Move elements 77, 44, 6 to the right.
* Moves: 3
* Insert 0 at the beginning.

**Array after**: 0, 6, 44, 77, 33, 66, 8, 88, 99, 11, 4, 22, 2, 55

**Main loop iteration i=4:**

* Array before: 0, 6, 44, 77, 33, 66, 8, 88, 99, 11, 4, 22, 2, 55
* Current element: 33
* Move elements 77,44 to the right.
* Moves: 2
* Insert 33 in the current position.

**Array after**: 0, 6, 33, 44, 77, 66, 8, 88, 99, 11, 4, 22, 2, 55

**Main loop iteration i=5**

* Array before: 0, 6, 33, 44, 77, 66, 8, 88, 99, 11, 4, 22, 2, 55
* Current element: 66
* Move element 77 to the right.
* Moves: 1
* Insert 66 in the correct position.

**Array after**: 0, 6, 33, 44, 66, 77, 8, 88, 99, 11, 4, 22, 2, 55

**Main loop iteration i=6:**

* Array before: 0, 6, 33, 44, 66, 77, 8, 88, 99, 11, 4, 22, 2, 55
* Current element: 8
* Move elements 77, 66, 44, 33 to the right.
* Moves: 4
* Insert 8 in the correct position.

**Array after**: 0, 6, 8, 33, 44, 66, 77, 88, 99, 11, 4, 22, 2, 55

**Main loop iteration i=7:**

* Array before: 0, 6, 8, 33, 44, 66, 77, 88, 99, 11, 4, 22, 2, 55
* Current element: 88
* No movement required (since 88>77), so the array remains unchanged.

**Array after**: 0, 6, 8, 33, 44, 66, 77, 88, 99, 11, 4, 22, 2, 55

**Main loop iteration i=8:**

* Array before: 0, 6, 8, 33, 44, 66, 77, 88, 99, 11, 4, 22, 2, 55
* Current element: 99
* No movement required (since 99>88), so the array remains unchanged.

**Array after**: 0, 6, 8, 33, 44, 66, 77, 88, 99, 11, 4, 22, 2, 55

**Main loop iteration i=9:**

* Array before: 0, 6, 8, 33, 44, 66, 77, 88, 99, 11, 4, 22, 2, 55
* Current element: 11
* Move elements 99, 88, 77, 66, 44, 33 to the right.
* Moves: 6
* Insert 11 in the correct position.

**Array after**: 0, 6, 8, 11, 33, 44, 66, 77, 88, 99, 4, 22, 2, 55

**Main loop iteration i=10:**

* Array before: 0, 6, 8, 11, 33, 44, 66, 77, 88, 99, 4, 22, 2, 55
* Current element: 4
* Move elements 99, 88, 77, 66, 44, 33, 11, 8, 6 to the right.
* Moves: 9
* Insert 4 in the correct position.

**Array after**: 0, 4, 6, 8, 11, 33, 44, 66, 77, 88, 99, 22, 2, 55

**Main loop iteration i=11:**

* Array before: 0, 4, 6, 8, 11, 33, 44, 66, 77, 88, 99, 22, 2, 55
* Current element: 22
* Move elements 99,88,77,66,44,33 to the right.
* Moves: 6
* Insert 22 in the correct position.

**Array after**: 0, 4, 6, 8, 11, 22, 33, 44, 66, 77, 88, 99, 2, 55

**Main loop iteration i=12:**

* Array before: 0, 4, 6, 8, 11, 22, 33, 44, 66, 77, 88, 99, 2, 55
* Current element: 2
* Move elements 99, 88, 77, 66, 44, 33, 22, 11, 8, 6, 4 to the right.
* Moves: 11
* Insert 2 in the correct position.

**Array after**: 0, 2, 4, 6, 8, 11, 22, 33, 44, 66, 77, 88, 99, 55

**Main loop iteration i=13i = 13i=13**

* Array before: 0, 2, 4, 6, 8, 11, 22, 33, 44, 66, 77, 88, 99, 55
* Current element: 555555
* Move elements 99,88,77,6699, 88, 77, 6699,88,77,66 to the right.
* Moves: 4
* Insert 555555 in the correct position.

**Array after**: 0, 2, 4, 6, 8, 11, 22, 33, 44, 55, 66, 77, 88, 99

**Summary**

* Total moves: 48
* Total insertions: 10

**Task 2**. Exponentiation by Squaring.

Manually execute “Exponentiation by Squaring” algorithm for computing .

Write values of the algorithm’s variables at the very beginning, after each loop iteration and after each change of . Explain with words at least of all steps; you may omit explanation, only when step is identical to some already explained one.

Use iterative version of exponentiation by squaring (not recursive one).

Case number 14.

(14).

First of all, let’s fix the algorithm being used:

def **mod\_exp**(a, m, c):

    b = a

    res = 1.0

**print**(f"b = {b}, m = {m}, res = {res} (Before loop start)")

    while m > 0:

        if m % 2 == 1:

            res \*= b

            res %= c

**print**(f"b = {b}, m = {m}, res = {res} (Odd m, update res)")

        m //= 2

        b \*= b

        b %= c

**print**(f"b = {b}, m = {m}, res = {res}")

    return res

Manual calculation process:

|  |  |  |  |
| --- | --- | --- | --- |
| b | m | res |  |
| 5860 | 6802 | 1 | Initial values before the loop starts. |
| 256 | 3401 | 1 | Value of was halved, and was squared and taken modulo 6331, as . |
| 256 | 3401 | 256 | is odd (3401), so is updated as |
| 2226 | 1700 | 256 | was halved, and was recalculated, |
| 4234 | 850 | 256 |  |
| 3695 | 425 | 256 |  |
| 3695 | 425 | 2601 |  |
| 3389 | 212 | 2601 |  |
| 887 | 106 | 2601 |  |
| 1725 | 53 | 2601 |  |
| 1725 | 53 | 4377 |  |
| 55 | 26 | 4377 |  |
| 3025 | 13 | 4377 |  |
| 3025 | 13 | 2304 |  |
| 2330 | 6 | 2304 |  |
| 3233 | 3 | 2304 |  |
| 3233 | 3 | 3576 |  |
| 6139 | 1 | 3576 |  |
| 6139 | 1 | 3487 | is odd (1), so is updated as |
| 5209 | 0 | 3487 | reached 0, ending the algorithm with the result |

**Main result:** .