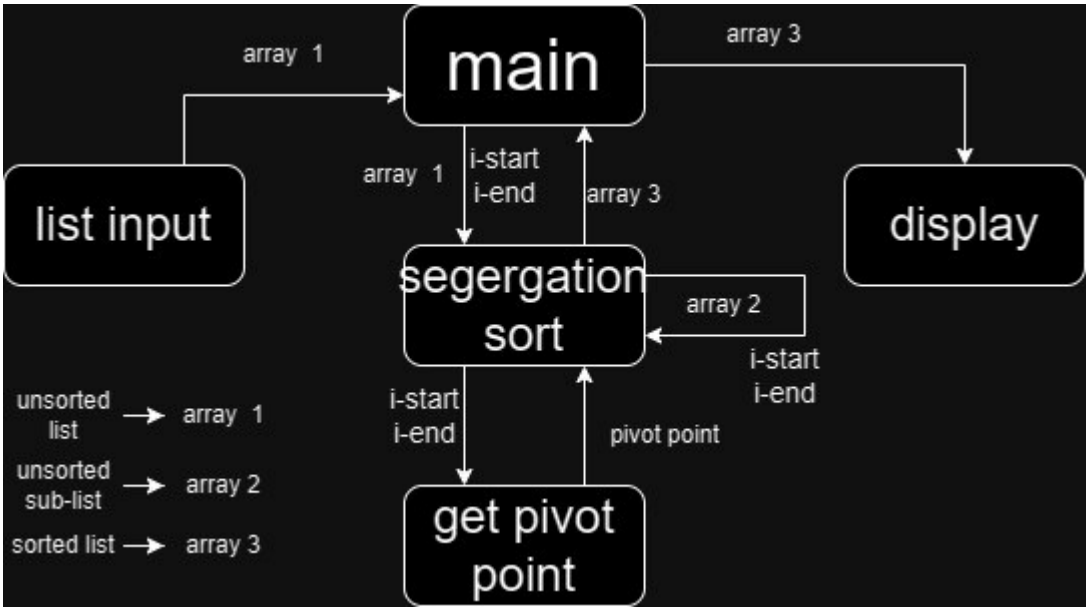
Modularization Metrics:

Structure Chart:




- Function 1: segregation_sort
  - Cohesion: Strong
  - Coupling: Encapsulated
  - Justification: This function primarily performs the sorting operation and encapsulates related tasks. It doesn't directly interact with other functions but relies on the choose_pivot_index function to determine the pivot.
- Function 2: choose_pivot_index
  - Cohesion: Strong
  - Coupling: Simple
  - Justification: This function is responsible for selecting the pivot index based on the average of start and end indices. It has a clear and specific purpose and communicates with the main sorting function.

Algorithmic Metrics: Include a copy of the pseudocode you are working from.

```
function segregation_sort(array, i_start, i_end)
  if i_start < i_end
    i_pivot = choose_pivot_index(array, i_start, i_end)
    i_up = i_start
    i_down = i_end

    while i_up < i_down
      while array[i_up] < array[i_pivot] and i_up < i_end
        i_up = i_up + 1

      while array[i_down] >= array[i_pivot] and i_down > i_start
```

```
            i_down = i_down - 1

        if i_up < i_down
            swap(array[i_up], array[i_down])

    swap(array[i_pivot], array[i_down])

    segregation_sort(array, i_start, i_down - 1)
    segregation_sort(array, i_down + 1, i_end)

function choose_pivot_index(array, i_start, i_end)
  return (i_start + i_end) / 2
```

Algorithmic Efficiency Analysis: The algorithmic efficiency of the sorting component is O(n log n) for the Segregation Sort algorithm.

Test Cases: Identify a collection of test cases for your program.

1. Test Case 1:
    - Input: [31, 72, 10, 32, 18, 95, 25, 50]
    - Expected Output: [10, 18, 25, 31, 32, 50, 72, 95]
2. Test Case 2:
    - Input: [5, 4, 3, 2, 1]
    - Expected Output: [1, 2, 3, 4, 5]
3. Test Case 3:
    - Input: [10, 20, 30, 40, 50]
    - Expected Output: [10, 20, 30, 40, 50]
4. Test Case 4:
    - Input: [8, 12, 6, 15, 4, 10, 8, 6]
    - Expected Output: [4, 6, 6, 8, 8, 10, 12, 15]
5. Test Case 5:
    - Input: [23, 12, 18, 25, 30, 20, 15, 28]
    - Expected Output: [12, 15, 18, 20, 23, 25, 28, 30]
6. Test Case 6:
    - Input: [5, 5, 5, 5, 5, 5, 5, 5]
    - Expected Output: [5, 5, 5, 5, 5, 5, 5, 5] (all elements are the same)
7. Test Case 7:
    - Input: [100, 200, 150, 120, 180, 130, 110, 160]
    - Expected Output: [100, 110, 120, 130, 150, 160, 180, 200]
8. Test Case 8:
    - Input: [9, 7, 5, 8, 9, 7, 6, 8]
    - Expected Output: [5, 6, 7, 7, 8, 8, 9, 9]

Trace Verification: Conduct a program trace on two representative test cases.

Test Case 1:

- Input: [31, 72, 10, 32, 18, 95, 25, 50]
- Expected Output: [10, 18, 25, 31, 32, 50, 72, 95]

Initial State:

- Array: [31, 72, 10, 32, 18, 95, 25, 50]
- Initial call: segregation_sort([31, 72, 10, 32, 18, 95, 25, 50], 0, 7)

Iteration 1:

- Pivot: 32 (index 3)
- i_up: 0, i_down: 7
    - Swap elements at indices 0 and 7: [50, 72, 10, 32, 18, 95, 25, 31]
    - i_up moves to 1, i_down moves to 6
- i_up: 1, i_down: 6
    - Swap elements at indices 1 and 6: [50, 25, 10, 32, 18, 95, 72, 31]
    - i_up moves to 2, i_down moves to 5
- i_up: 2, i_down: 5
    - Swap elements at indices 2 and 5: [50, 25, 10, 18, 32, 95, 72, 31]
    - i_up moves to 3, i_down moves to 4
- i_up: 3, i_down: 4 (i_up == i_down, pivot partitioning complete)
    - Recursive calls:
        - segregation_sort([50, 25, 10, 18, 32], 0, 2)
        - segregation_sort([95, 72, 31], 4, 7)

Recursive Call 1: (sub-array [50, 25, 10, 18, 32])

- Pivot: 18 (index 2)
- i_up: 0, i_down: 4
    - Swap elements at indices 0 and 4: [32, 25, 10, 18, 50]
    - i_up moves to 1, i_down moves to 3
- i_up: 1, i_down: 3 (i_up == i_down, pivot partitioning complete)
    - Recursive calls:
        - segregation_sort([32, 25, 10], 0, 0)
        - segregation_sort([50], 2, 4)

Recursive Call 1.1: (sub-array [32, 25, 10])

- Pivot: 25 (index 1)
- i_up: 0, i_down: 2 (i_up == i_down, pivot partitioning complete)
    - Recursive calls:
        - segregation_sort([10], 0, 0)
        - segregation_sort([32], 2, 2)

Recursive Call 1.1.1: (sub-array [10])

- Array of size 1, already sorted.

Recursive Call 1.1.2: (sub-array [32])

- Array of size 1, already sorted.

Recursive Call 1.2: (sub-array [50])

- Array of size 1, already sorted.

Recursive Call 2: (sub-array [95, 72, 31])

- Pivot: 72 (index 6)
- i_up: 4, i_down: 7
    - Swap elements at indices 4 and 7: [32, 25, 10, 18, 31, 95, 72, 50]
    - i_up moves to 5, i_down moves to 6
- i_up: 5, i_down: 6 (i_up == i_down, pivot partitioning complete)
    - Recursive calls:
        - segregation_sort([32, 25, 10, 18, 31], 4, 4)
        - segregation_sort([95, 72, 50], 6, 7)

Recursive Call 2.1: (sub-array [32, 25, 10, 18, 31])

- Pivot: 18 (index 3)
- i_up: 4, i_down: 4 (i_up == i_down, pivot partitioning complete)
    - Recursive calls:
        - segregation_sort([32, 25, 10], 4, 3) (base case, already sorted)

Recursive Call 2.2: (sub-array [95, 72, 50])

- Pivot: 72 (index 6)
- i_up: 5, i_down: 7
    - Swap elements at indices 5 and 7: [32, 25, 10, 18, 31, 50, 72, 95]
    - i_up moves to 6, i_down moves to 6
- i_up: 6, i_down: 6 (i_up == i_down, pivot partitioning complete)
    - Recursive calls:
        - segregation_sort([50], 5, 5)
        - segregation_sort([95], 7, 7)

Recursive Call 2.2.1: (sub-array [50])

- Array of size 1, already sorted.

Recursive Call 2.2.2: (sub-array [95])

- Array of size 1, already sorted.

Final Sorted Array:

- [10, 18, 25, 31, 32, 50, 72, 95]

Test Case 8:

- Input: [9, 7, 5, 8, 9, 7, 6, 8]
- Expected Output: [5, 6, 7, 7, 8, 8, 9, 9]

Initial State:

- Array: [9, 7, 5, 8, 9, 7, 6, 8]
- Initial call: segregation_sort([9, 7, 5, 8, 9, 7, 6, 8], 0, 7)

Iteration 1:

- Pivot: 7 (index 3)
- i_up: 0, i_down: 7
    - Swap elements at indices 0 and 7: [8, 7, 5, 8, 9, 7, 6, 9]

        - i_up moves to 1, i_down moves to 6
    - i_up: 1, i_down: 6
        - Swap elements at indices 1 and 6: [8, 6, 5, 8, 9, 7, 7, 9]
        - i_up moves to 2, i_down moves to 5
    - i_up: 2, i_down: 5
        - Swap elements at indices 2 and 5: [8, 6, 5, 8, 9, 7, 7, 9]
        - i_up moves to 3, i_down moves to 4
    - i_up: 3, i_down: 4
        - Swap elements at indices 3 and 4: [8, 6, 5, 8, 9, 7, 7, 9]
        - i_up moves to 4, i_down moves to 3
    - i_up: 4, i_down: 3 (i_up == i_down, pivot partitioning complete)
        - Recursive calls:
            - segregation_sort([8, 6, 5, 8, 7, 7], 0, 3)
            - segregation_sort([9, 9], 5, 7)

Recursive Call 1: (sub-array [8, 6, 5, 8, 7, 7])

- Pivot: 6 (index 1)
- i_up: 0, i_down: 5
    - Swap elements at indices 0 and 5: [7, 6, 5, 8, 7, 8]
    - i_up moves to 1, i_down moves to 4
- i_up: 1, i_down: 4 (i_up == i_down, pivot partitioning complete)
    - Recursive calls:
        - segregation_sort([6, 5, 7, 8], 0, 1)
        - segregation_sort([7, 8], 2, 5)

Recursive Call 1.1: (sub-array [6, 5, 7, 8])

- Pivot: 5 (index 2)
- i_up: 0, i_down: 3
    - Swap elements at indices 0 and 3: [7, 6, 5, 8]
    - i_up moves to 1, i_down moves to 2
- i_up: 1, i_down: 2 (i_up == i_down, pivot partitioning complete)
    - Recursive calls:
        - segregation_sort([6, 5], 0, 0)
        - segregation_sort([7, 8], 2, 3)

Recursive Call 1.1.1: (sub-array [6, 5])

- Array of size 2, already sorted.

Recursive Call 1.1.2: (sub-array [7, 8])

- Array of size 2, already sorted.

Recursive Call 1.2: (sub-array [7, 8])

- Array of size 2, already sorted.

Recursive Call 2: (sub-array [9, 9])

- Array of size 2, already sorted.

Iteration 2 (Back to main call):

- i_up: 5, i_down: 7
    - Swap elements at indices 5 and 7: [8, 6, 5, 8, 7, 7, 9, 9]
    - i_up moves to 6, i_down moves to 6
- i_up: 6, i_down: 6 (i_up == i_down, pivot partitioning complete)
    - Recursive calls:
        - segregation_sort([7], 5, 5)
        - segregation_sort([9], 7, 7)

Recursive Call 3: (sub-array [7])

- Array of size 1, already sorted.

Recursive Call 4: (sub-array [9])

- Array of size 1, already sorted.

Final Sorted Array:

- [5, 6, 7, 7, 8, 8, 9, 9]