LAB 1

SEMISTER 3rd

fall-2024

SUBJECT

Database Structures

COURSE CODE

CC210

PROGRAMME

BS (4 year)

ABBOTTABAD UNIVERSITY OF SCIENCE AND TECHNOLOGY ISLAMABAD

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Exercise 1

Task 1:

Sort an array of 10 random integers using the merge sort function and observe the output.

```
def merge_sort(arr):
    if len(arr) > 1:
        # Find the middle point to divide the array into two halves
        mid = len(arr) // 2
        left_half = arr[:mid]
        right_half = arr[mid:]

        # Recursively sort the two halves
        merge_sort(left_half)
        merge_sort(right_half)

        # Merge the sorted halves
        merge(arr, left_half, right_half)
def merge(arr, left_half, right_half):
    i = j = k = 0

    # Copy data to temporary arrays left_half[] and right_half[]
    while i < len(left_half) and j < len(right_half):
        if left_half[i] < right_half[j]:
            arr[k] = left_half[i]
            i += 1
        else:
            arr[k] = right_half[j]
            j += 1
        k += 1
```

```
    # Check for any remaining elements
    while i < len(left_half):
        arr[k] = left_half[i]
        i += 1
        k += 1

    while j < len(right_half):
        arr[k] = right_half[j]
        j += 1
        k += 1

# Driver code to test the merge_sort function
if __name__ == "__main__":
    arr = [12, 11, 13, 5, 6, 7,5,6,8,3]
    print("Original array:", arr)
    merge_sort(arr)
    print("Sorted array:", arr)
```

Output:

```
Original array: [12, 11, 13, 5, 6, 7, 5, 6, 8, 3]
Sorted array: [3, 5, 5, 6, 6, 7, 8, 11, 12, 13]
```

Task 2:

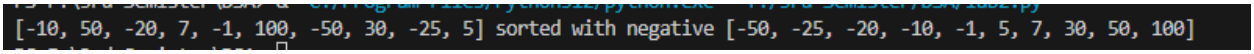
Modify the input array to include negative numbers and test the function.

```
def merge_sort(arr):
    if len(arr) > 1:
        mid = len(arr) // 2
        left_half = arr[:mid]
        right_half = arr[mid:]
```

```
    # Recursive calls for each half
    merge_sort(left_half)
    merge_sort(right_half)

    # Merging the two halves
    i = j = k = 0

    while i < len(left_half) and j < len(right_half):
        if left_half[i] < right_half[j]:
            arr[k] = left_half[i]
            i += 1
        else:
            arr[k] = right_half[j]
            j += 1
        k += 1

    while i < len(left_half):
        arr[k] = left_half[i]
        i += 1
        k += 1

    while j < len(right_half):
        arr[k] = right_half[j]
        j += 1
        k += 1

  return arr

# Task 2: Modify the array to include negative numbers and test the merge_sort function.
```

```
# # # Array with negative numbers

if __name__ == "__main__":

    test_array_with_negatives = [-10, 50, -20, 7, -1, 100, -50, 30, -25, 5]

# Sorting the array with merge_sort

    sorted_array_with_negatives = merge_sort(test_array_with_negatives[:])  # Copying to avoid
modifying the original


    print(test_array_with_negatives,"sorted with negative", sorted_array_with_negatives)
```

Output:



Task 3:

Measure the time complexity of the merge_sort function using the time module for an array of size n where n = 100, 1000, 10000.

```
import random

import time


# Define the merge_sort function again (since the environment was reset)

def merge_sort(arr):

    if len(arr) > 1:

        mid = len(arr) // 2

        left_half = arr[:mid]

        right_half = arr[mid:]


        # Recursive calls for each half

        merge_sort(left_half)

        merge_sort(right_half)
```

```
        # Merging the two halves
        i = j = k = 0

        while i < len(left_half) and j < len(right_half):
            if left_half[i] < right_half[j]:
                arr[k] = left_half[i]
                i += 1
            else:
                arr[k] = right_half[j]
                j += 1
            k += 1

        while i < len(left_half):
            arr[k] = left_half[i]
            i += 1
            k += 1

        while j < len(right_half):
            arr[k] = right_half[j]
            j += 1
def measure_time(n):
    arr=[random.randint(0,10000) for _ in range(n)]
    start_time=time.time()
    merge_sort(arr)
    end_time=time.time()
    return end_time - start_time

sizes=[100,1000,10000]
results={}
```

```
for size in sizes:
    elapsed_time=measure_time(size)
    results[size]=elapsed_time
    print(f"Time to sort array of size {size}: {elapsed_time:.6f} seconds")

print("\nTime complexity results:")
for size, elapsed in results.items():
    print(f"Size: {size}, Time taken: {elapsed:.6f} seconds")
```

Output:

```
Time to sort array of size 100: 0.001354 seconds
Time to sort array of size 1000: 0.004293 seconds
Time to sort array of size 10000: 0.075478 seconds

Time complexity results:
Size: 100, Time taken: 0.001354 seconds
Size: 1000, Time taken: 0.004293 seconds
Size: 10000, Time taken: 0.075478 seconds
```

Exercise 2

Task 1:

Sort an array of 10 random integers using the insertion_sort function and observe the output.

Task 2:

Modify the input array to include negative numbers and test the function.

Task 3:

Measure the time complexity of the insertion_sort function using the time module for different array sizes (e.g., 100, 1000, 10000).

```
import random
import time

# Define the insertion sort function
```

```
def insertion_sort(arr):
    for i in range(1, len(arr)):
        key = arr[i]
        j = i - 1
        while j >= 0 and key < arr[j]:
            arr[j + 1] = arr[j]
            j -= 1
        arr[j + 1] = key
    return arr


# Task 1: Sorting a random array of 10 integers
test_array_1 = random.sample(range(1, 101), 10)  # Array with random integers between 1 and 100
sorted_array_1 = insertion_sort(test_array_1[:])  # Copy to prevent in-place sorting during the test
print("Task 1 - Original array:", test_array_1)
print("Task 1 - Sorted array:", sorted_array_1)


# Task 2: Modify the array to include negative numbers and test
test_array_2 = random.sample(range(-50, 51), 10)  # Array with random integers between -50 and 50
sorted_array_2 = insertion_sort(test_array_2[:])
print("\nTask 2 - Original array (with negatives):", test_array_2)
print("Task 2 - Sorted array:", sorted_array_2)


# Task 3: Measure time complexity with different array sizes
def measure_time_complexity(array_size):
    test_array = [random.randint(-1000, 1000) for _ in range(array_size)]  # Random integers between -1000 and 1000
```

```
    start_time = time.time()
    insertion_sort(test_array)
    end_time = time.time()
    return end_time - start_time

# Measure for 100, 1000, and 10000 elements
time_100 = measure_time_complexity(100)
time_1000 = measure_time_complexity(1000)
time_10000 = measure_time_complexity(10000)

print("\nTask 3 - Time complexity results:")
print("Time for 100 elements: {:.6f} seconds".format(time_100))
print("Time for 1000 elements: {:.6f} seconds".format(time_1000))
print("Time for 10000 elements: {:.6f} seconds".format(time_10000))
```

Output: