Assignment 9

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1.Write a greedy algorithm that accepts a list of given tasks with their processing time and decides their processing order to minimize the average completion time.

Below is the pseudocode for the algorithm:

```
1. Function find_min_completion_time(tasks):
2.     Sort tasks in ascending order of processing time
3.     waiting_time = 0
4.     total_time = 0
5.     For i, (task, time) in enumerate(tasks):
6.         completion_time = time + waiting_time
7.         waiting_time += time
8.         total_time += completion_time
9.         Update tasks[i] = (task, time, completion_time)
10.    Calculate avg_time = total_time / len(tasks)
11.    Return tasks, avg_time
```

2. Prove that your algorithm indeed finds the minimum average completion time.

The algorithm sorts tasks in ascending order by their processing time. By doing so, tasks with smaller processing times are scheduled earlier. This ensures that their contribution to the overall waiting time of subsequent tasks is minimized. By reducing the waiting time, the average completion time is also minimized. This follows the principle of the Shortest Processing Time First (SPT) scheduling, which is proven to minimize the total completion time and, consequently, the average completion time.

3.Find the time complexity of your algorithm in the form of O(f(n)) and justify the conclusion.

The algorithm has the following steps:
1. **Sorting**: Sorting the tasks based on processing time takes $O(n \log n)$, where n is the number of tasks.
2. **Looping**: The loop iterates over each task to calculate the completion times and update the task list, which takes $O(n)$.

Thus, the overall time complexity is:

$$O(n \log n)$$

This is justified as the sorting step dominates the total computation time.

4.Implement this algorithm and test it with sample inputs.

Below is the program's output for sample input

```
Input: [('a1', 5), ('a2', 3)]
Output
Task id  Processing Time  Completion Time
a2       3                3
a1       5                8
Average completion time: 5.5

Input: [('a1', 4), ('a2', 8), ('a3', 2)]
Output
Task id  Processing Time  Completion Time
a3       2                2
a1       4                6
a2       8                14
Average completion time: 7.33

Input: [('a1', 10), ('a2', 3), ('a3', 7), ('a4', 1), ('a5', 2)]
Output
Task id  Processing Time  Completion Time
a4       1       1
a5       2       3
a2       3       6
a3       7       13
a1       10      23
Average completion time: 9.2
```