Curtin University: School of Electrical Engineering, Computing and Mathematical Sciences Curtin

COMP1002 | Data structures and Algorithms

Final Assignment: Optimising Urban Parcel Logistics Using Data Structures and Algorithms

Description

CityDrop Logistics is expanding its operations in a metropolitan area and required me to develop a suite of inter-connected software modules to optimise there delivery network.

I ended up developing a system that is divided into four modules that are interconnected:

1. Graph Based Route Planning :- This allows CityDrop Logistics to determine the most effective and efficient paths from a hub to a destination
2. Hash Based Customer Lookup :- This allows CityDrop Logistics to retrieve customer information quickly
3. Heap Based Parcel Scheduling :- This allows CityDrop Logistics to prioritise deliveries based on urgency and customer priority
4. Sorting of Delivery Records :- This allows CityDrop Logistics to organise records at the end of the day usign Merge and Quick sorts

Getting Started

Dependencies

- Python 3.13
    - [x] Numpy

Recommended

- Microsoft VSCode
    - [x] Pylance
    - [x] Python
    - [x] Python Debugger
    - [x] Rainbow CSV

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Overview

CityDrop Logistics is expanding its operations in a metropolitan area and required me to develop for them, a suite of inter-connected software modules to optimise their delivery network.

In the end, I ended up developing four inter-connected modules of software that communicate between one another that allows CityDrop logistics to effectively and efficiently add, schedule and sort customer packages and parcels.

Each system that I implemented utilised the various self implemented data structures and algorithms such as *graphs, hashes, heaps, linked lists, stack and queues, quick sort* and *merge sort*.

The systems that I developed include:

1. ### Graph Based Route Planning

   This module allows CityDrop logistics to manipulate their delivery network by allowing them to add and remove delivery hubs/intersections as well as the routes between those hubs and intersections. It also allows them to display their network and perform automated tasks such as determining the shortest path from a hub/intersection to a destination (Dijkstra's Shortest Path), performing Breadth-First searches and Depth-First searches to determine accessible delivery zones from a hub/intersection as well as any cycles in their network that would be inefficient.

   This software module utilises the *graph* data structure. Additionally, this module easily and simply integrates into the subsequent modules.

2. ### Hash Based Customer Look Up

   This module allows CityDrop logistics to manage customers in their company. This module allows them to add/remove customers as well as check if a customer exists. Furthermore, it allows CityDrop logistics to load/save customer data from/to a CSV file for easy data management. The system is able to detect whether a customer being added to the system has a valid address from a hub/intersection which is loaded from module one and similarly the system is able to handle collisions in the hash table which can be verified by the use of the collision example. When a customer is added the system is able to update delivery status and the hash table can be displayed. The module takes graph data from module one to determine estimated delivery time (Dijkstra's Algorithm) and the aforementioned valid destinations and hubs.

   This module utilises the *hash table* data structure and this module communicates with subsequent modules.

3. Heap Based Parcel Scheduling

This module allows CityDrop logistics to schedule parcels from customer data from module two which can easily be imported directly or from a CSV file from the prior module. This module also calculates the priority of the delivery based on the following formula

$$P = (6 - p) + \frac{1000}{T}$$

Where P is the calculated priority, p is the customer priority from 1 to 5, and T is the estimated delivery time. This information is retrieved from the previous module. The heap itself extracts the scheduled deliveries based on highest calculated priority and this data can then be loaded into subsequent or prior modules or exported as a CSV file. When customer data is loaded into this module, the system updates the delivery status to "In-Transit" and when a delivery is completed, it can be removed from the scheduler (heap) where its status is set to "Delivered", the completed deliveries can then be exported to a CSV file.

This module utilises *heaps* as its data structure and this module communicates with subsequent modules.

4. Sorting Delivery Records

This module allows CityDrop Logistics to sort the deliveries using *quick* and *merge* sorts at the end of the day for reporting purposes. Completed deliveries are re-loaded back into the previous module then, they are sorted in this module where they can perform one of the following sorts:

i. Merge Sort
ii. Quick Sort
iii. Quick Sort (Pivot is a Median of Three Values)
iv. Quick Sort (Pivot is a Random Value)

When sorted, the data is presented in a sorted order based on shortest delivery time to longest delivery time as well as how long it took to sort the data. Finally, CityDrop Logistics has the ability to do sorts on super large sets of sorted data which is done by loading a CSV file which has nine different test cases for 100, 500 and 1000 delivery records.

Data Structures Used

1. Why Graphs?

Graphs were the most obvious choice for module one. This is because the nodes of a graph can be used to represent each hub/intersection, and the routes can easily be represented by edges.

Additionally, the edges of the graph can be weighted, which means that the travel time can be assigned between each hub/intersection/destination. The weighting is particularly useful for calculating the shortest path from one point to another using Dijkstra's Shortest Path Algorithm.

An important aspect of this first module was that the shortest path from one hub to another had to be determined. Dijkstra's shortest path algorithm was the best choice for this, and this method works with graphs which meant that graphs was a good choice for module one.

Further requirements meant that any cycles in the network and disconnected hubs had to be determined, and this can be done using Breadth-First and Depth First searches which work with the graph data structure.

Hence, for module one, the graph data structure was determined to be the most suitable data structure and hence which is why it has been used in the project.

2. Why Hash Tables?

Hash tables were the most obvious choice for module two. This is because hash tables offer fast lookups and efficient data management. Hash tables are efficient in managing data because as the number of customers grows, the hash table has the ability to resize depending on the load factor (increasing when >0.7 and decreasing when <0.3).

The implementation of a "good" hashing function allows the hash table to minimise collisions which allows for a good spread/distribution of entries. Linear probing in the hash tables ensures that in the event of a collision, the hash table will deal with the collision by moving the entry to the next available entry that has not been used.

Hash tables were also a good choice based on the implementation of the hash entry object itself which is able to store all of the necessary information which allows all of the required information to be stored without having to strip the information and go about substituting it back after hashing is complete.

Hence, for module two, the hash table was determined to be the most suitable data structure and hence which is why it has been used in the project.

3. Why Heaps?

Heaps were the most obvious choice for module three. This is because it offers efficient management of parcels based on calculated priority. Furthermore, as the module is frequently requiring access to the highest priority item, it is able to efficiently access that information.

The use of a *max* heap in the project ensures that the value of each parent node is greater than or equal to the values of its children, this ensures that the root element is always the highest priority element.

In essence, the *max* heap which has been implemented in this project is a pseudo priority queue.

Hence, for module three, the heap was determined to be the most suitable data structure and hence why it has been used in this project.

4. Why use Sorting Algorithms?

The use of sorting algorithms was essential as it was a requirement to sort the delivery records at the end of the day based on delivery times. Due to nature of the application; a situation where there could be potentially hundreds if not thousands of deliveries it only made sense to choose efficient and quick sorting algorithms. In this case, that was the use of *Quick* and *Merge* sorts.

The *quick* sort was chosen as one of the sorting algorithms for a few reasons. Firstly, it is an *in-place* sort. This means that data is efficiently sorted within the original array and does not need additional overheads or other temporary arrays making it ideal in low memory situations, this also means that more data can be added to an array without having to factor in overheads.

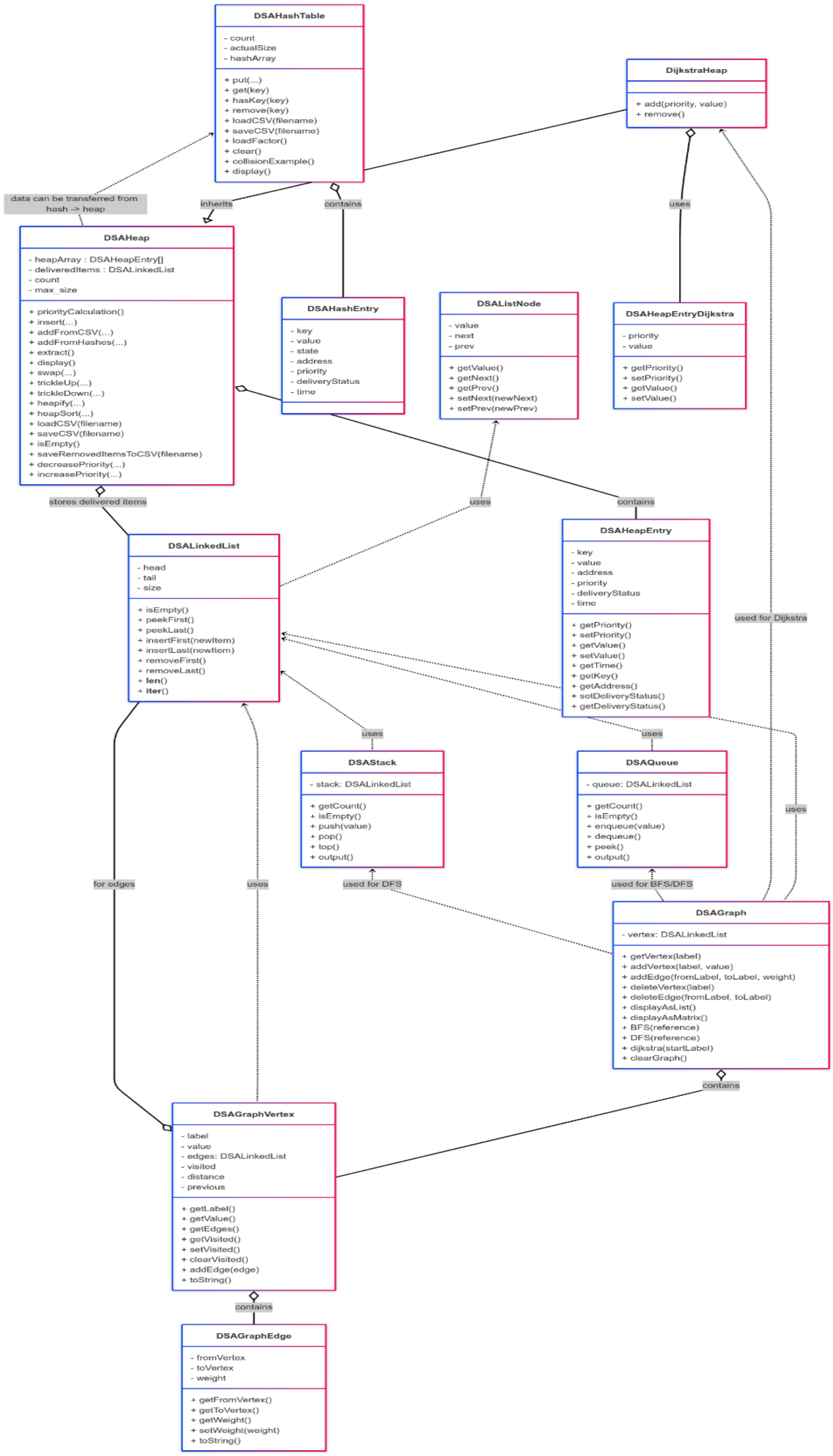
However, this sorting algorithm is not always the best choice, particularly when presented with completely reversed data where it slows down a lot. In this case, it is better to use *Merge* sort.

Merge sort has also been implemented for several reasons. First of all, merge sort is a very stable sort where in all cases for all types or ordered data, (reversed, random etc.) it performs identically. This particular case makes it far better than the *quick* sort.

However, the downside to *Merge* sort is that it is not an in-place sort which means that it requires an additional array to keep temporary storage of the sorting array which is a trade off for stability and the guaranteed sorting speed when compared to *quick* sort.

Hence, for module two, *Quick* and *Merge* sorts have been implemented into the project due to there good performance with both having their own pros and cons allowing CityDrop Logistics to determine what should be utilised in each situation they face.

Module Integration



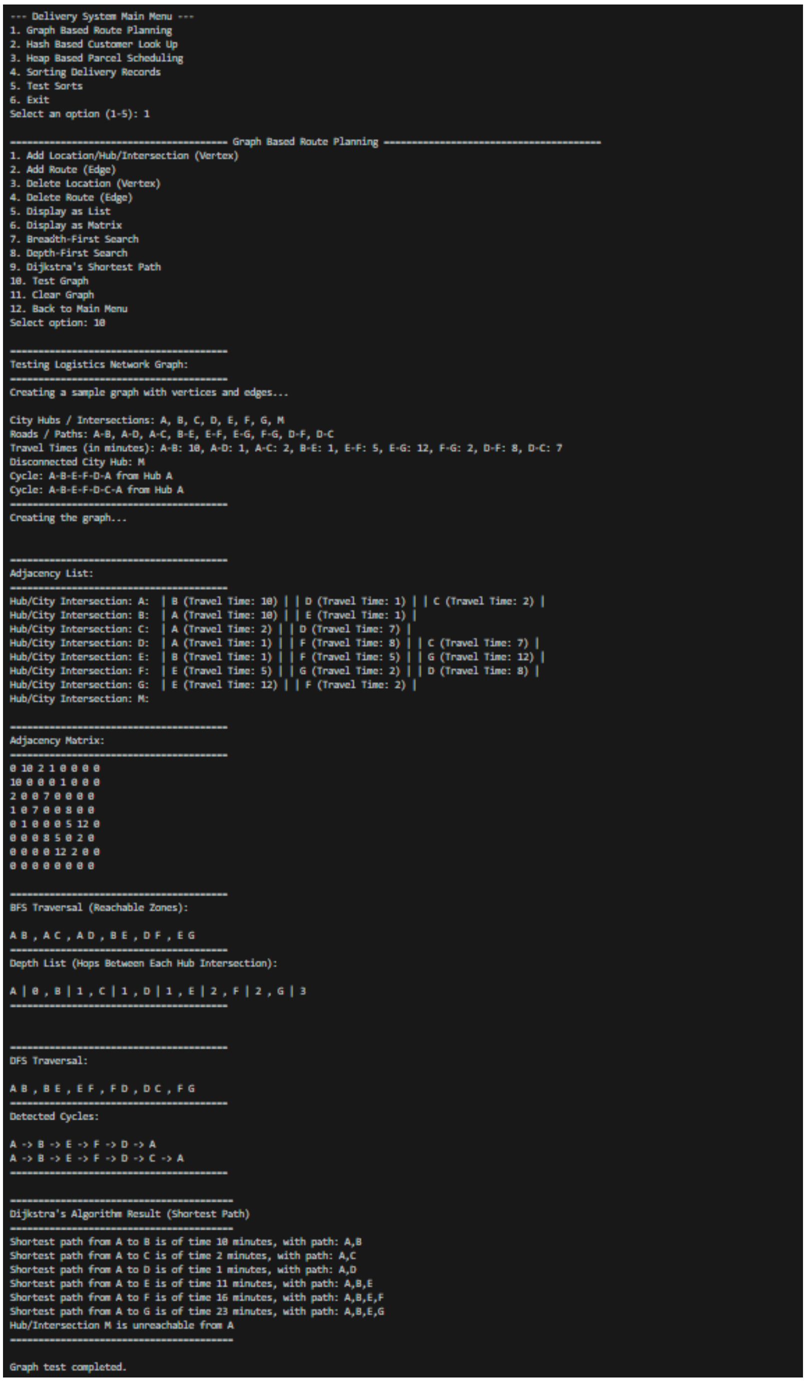
Algorithm Complexity Analysis

Module	Algorithm/Operation	Time Complexity	Space Complexity	Reason
1 Graphs	Add Vertex	O(V)	O(1)	Traverses for duplicates and adds O(1)
	Get Vertex	O(V)	O(1)	Traverses through linked list
	Add Edge	O(E)	O(1)	Checks for duplicate edges then adds edge O(1)
	Delete Edge	O(E)	O(1)	Removes edge from both vertices (2 x O(E))
	Display as List	O(V + E)	O(1)	Iterates all vertices and edges
	Display as Matrix	$O(V^2)$	$O(V^2)$	Fills and prints matrix it does a double loop over vertices
	BFS w/ Depth Detection	O(V + E)	O(V)	Standard BFS over all vertices and edges. Space complexity for the depth list for depth of vertices.
	DFS w/ Cycle Detection	O(V + E)	O(V)	Standard DFS over all vertices and edges. Space complexity for the visited list for the cycles.
	Dijkstra	O((V + E) Log V)	O(V)	Each vertex added to heap once and heap operations are O(log V).
	Clear Graph	O(V)	O(1)	Traverses list of vertices and resets values .
	Sort Adjacent List	$O(E^2)$	O(E)	Double loop over the list of edges.
2 Hashes	Put Get Has Key Remove	O(1)	O(N)	Linear probing is O(1) and hash table has O(N) space where N is number of entries.
	Hash	O(N)	O(1)	Hashes over the number of characters in the string
	Find Slot	O(1)	O(1)	Linear Probing
	Resize	O(N)	O(N)	Rehashes N number of entries and allocates new array of N size
	Next Prime	O(N sqrt(N))	O(1)	Primes are checked up to the square root of the new size N
	Save CSV	O(N)	O(1)	Iterates over all entries to write
	Load CSV	O(N)	O(N)	Iterates over N rows of the CSV file and does one "Put" per row
	Load Factor	O(1)	O(1)	Divides two numbers
	Clear	O(N)	O(1)	Empties the array over N number of elements and creates a new array with self.actualsize = 0, hence 2 elements
	Display	O(N)	O(1)	Prints each slot
3 Heaps	Priority Calculation	O(1)	O(1)	Calculates the priority using an the equation
	Insert Add From CSV Add from Hashes	O(Log N)	O(1)	Insert at end and Trickle Up

3 Heaps Cont.	Extract	O(Log N)	O(1)	Remove the root and trickle down
	Display	O(N)	O(1)	Iterate through heap elements
	Swap	O(1)	O(1)	Swap two elements
	Trickle Up	O(Log N)	O(1)	Standard heap operation
	Trickle Down			
	Heapify	O(N)	O(1)	Iterates from last non-leaf node and calls Trickle Down for each node from the last non-leaf node to root node.
	Heap Sort	O(N Log N)	O(1)	Standard heap sort.
	Decrease Priority	O(N Log N)	O(1)	Update Trickle Down
	Increase Priority			Update Trickle Up
	Load CSV	O(N Log N)	O(N)	For N number of entries there is and then N inserts. Space complexity of N number of entries in heap.
	Save CSV	O(N)	O(1)	Write all heap entries
	Is Empty	O(1)	O(1)	Checks heap count
	Save Removed to CSV	O(N)	O(1)	For N number od delivered items write to a CSV.
4 Sorts	Merge Sort	O(N Log N) Best/Average / Worst	O(N)	Recursively split and merge, space complexity comes from temp arrays.
	Quick Sort	O(N Log N) Best/Average and O(N^2) Worst	O(Log N)	Standard quick sort that selects a pivot and partition list into two halves, one with elements less than pivot and one with elements greater than pivot and recursively sorts each half. Space complexity is due to number of recursive calls.

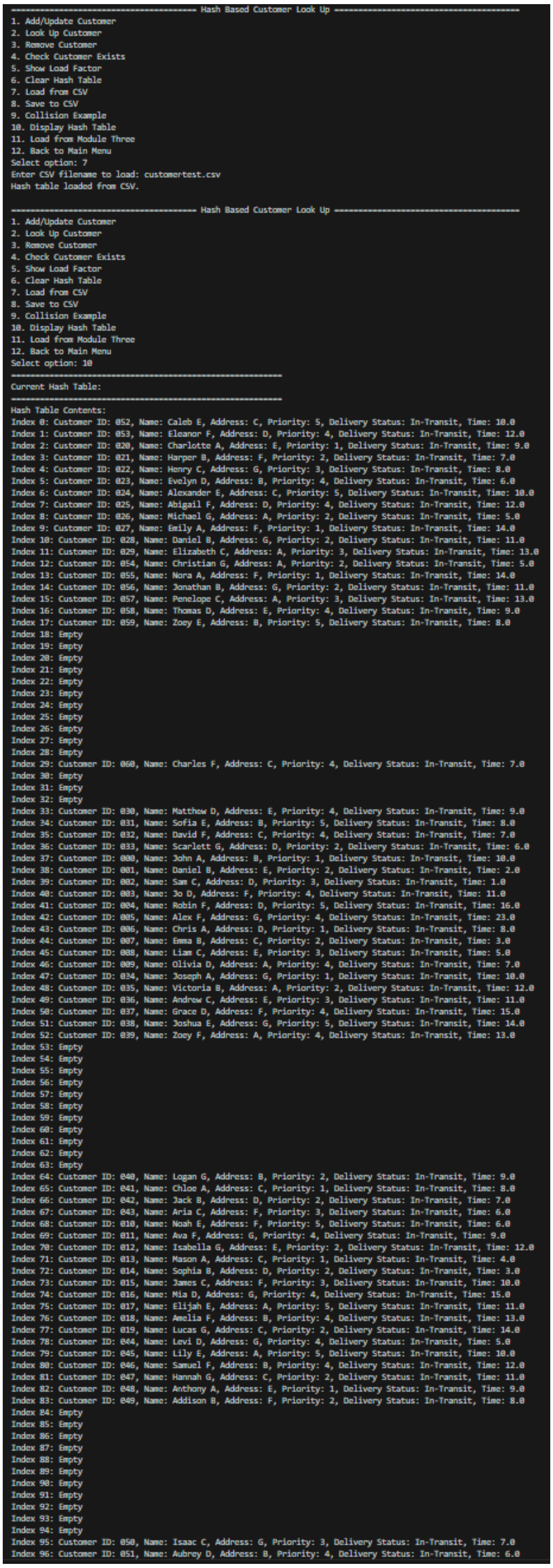
Sample Output

Please note that due to the sheer size of the test cases for the sorting algorithms, I have provided examples for all of the 100 element sorts. 500 and 1000 element sort test can be run using the program with instructions given in the README.md or README.pdf.



```
--- Delivery System Main Menu ---
1. Graph Based Route Planning
2. Hash Based Customer Look Up
3. Heap Based Parcel Scheduling
4. Sorting Delivery Records
5. Test Sorts
6. Exit
Select an option (1-5): 1

--------------------------------------- Graph Based Route Planning ---------------------------------------
1. Add Location/Hub/Intersection (Vertex)
2. Add Route (Edge)
3. Delete Location (Vertex)
4. Delete Route (Edge)
5. Display as List
6. Display as Matrix
7. Breadth-First Search
8. Depth-First Search
9. Dijkstra's Shortest Path
10. Test Graph
11. Clear Graph
12. Back to Main Menu
Select option: 10

----------------------------------------
Testing Logistics Network Graph:
----------------------------------------
Creating a sample graph with vertices and edges...

City Hubs / Intersections: A, B, C, D, E, F, G, M
Roads / Paths: A-B, A-D, A-C, B-E, E-F, E-G, F-G, D-F, D-C
Travel Times (in minutes): A-B: 10, A-D: 1, A-C: 2, B-E: 1, E-F: 5, E-G: 12, F-G: 2, D-F: 8, D-C: 7
Disconnected City Hub: M
Cycle: A-B-E-F-D-A from Hub A
Cycle: A-B-E-F-D-C-A from Hub A
----------------------------------------
Creating the graph...


----------------------------------------
Adjacency List:
----------------------------------------
Hub/City Intersection: A:  | B (Travel Time: 10) | | D (Travel Time: 1) | | C (Travel Time: 2) |
Hub/City Intersection: B:  | A (Travel Time: 10) | | E (Travel Time: 1) |
Hub/City Intersection: C:  | A (Travel Time: 2) | | D (Travel Time: 7) |
Hub/City Intersection: D:  | A (Travel Time: 1) | | F (Travel Time: 8) | | C (Travel Time: 7) |
Hub/City Intersection: E:  | B (Travel Time: 1) | | F (Travel Time: 5) | | G (Travel Time: 12) |
Hub/City Intersection: F:  | E (Travel Time: 5) | | G (Travel Time: 2) | | D (Travel Time: 8) |
Hub/City Intersection: G:  | E (Travel Time: 12) | | F (Travel Time: 2) |
Hub/City Intersection: M:

----------------------------------------
Adjacency Matrix:
----------------------------------------
0 10 2 1 0 0 0 0
10 0 0 0 1 0 0 0
2 0 0 7 0 0 0 0
1 0 7 0 0 8 0 0
0 1 0 0 0 5 12 0
0 0 0 8 5 0 2 0
0 0 0 0 12 2 0 0
0 0 0 0 0 0 0 0

----------------------------------------
BFS Traversal (Reachable Zones):

A B , A C , A D , B E , D F , E G
----------------------------------------
Depth List (Hops Between Each Hub Intersection):

A | 0 , B | 1 , C | 1 , D | 1 , E | 2 , F | 2 , G | 3
----------------------------------------


----------------------------------------
DFS Traversal:

A B , B E , E F , F D , D C , F G
----------------------------------------
Detected Cycles:

A -> B -> E -> F -> D -> A
A -> B -> E -> F -> D -> C -> A
----------------------------------------

-----------------------------------------
Dijkstra's Algorithm Result (Shortest Path)
-----------------------------------------
Shortest path from A to B is of time 10 minutes, with path: A,B
Shortest path from A to C is of time 2 minutes, with path: A,C
Shortest path from A to D is of time 1 minutes, with path: A,D
Shortest path from A to E is of time 11 minutes, with path: A,B,E
Shortest path from A to F is of time 16 minutes, with path: A,B,E,F
Shortest path from A to G is of time 23 minutes, with path: A,B,E,G
Hub/Intersection M is unreachable from A
-----------------------------------------

Graph test completed.
```

Fig 1 – Loading of Test Graph with Output

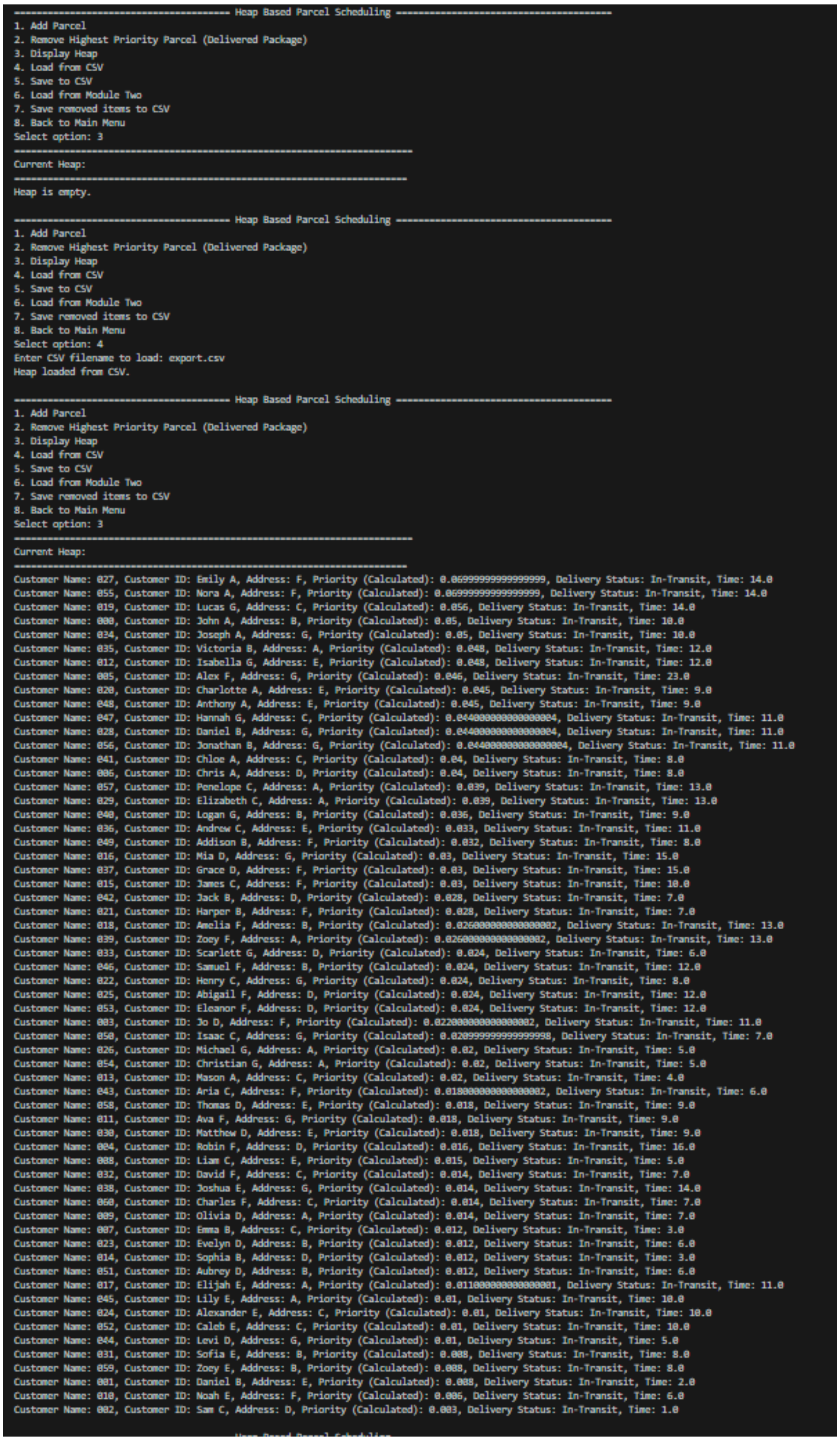


```
---------------------------------------- Hash Based Customer Look Up ----------------------------------------
1. Add/Update Customer
2. Look Up Customer
3. Remove Customer
4. Check Customer Exists
5. Show Load Factor
6. Clear Hash Table
7. Load from CSV
8. Save to CSV
9. Collision Example
10. Display Hash Table
11. Load from Module Three
12. Back to Main Menu
Select option: 7
Enter CSV filename to load: customertest.csv
Hash table loaded from CSV.

---------------------------------------- Hash Based Customer Look Up ----------------------------------------
1. Add/Update Customer
2. Look Up Customer
3. Remove Customer
4. Check Customer Exists
5. Show Load Factor
6. Clear Hash Table
7. Load from CSV
8. Save to CSV
9. Collision Example
10. Display Hash Table
11. Load from Module Three
12. Back to Main Menu
Select option: 10
----------------------------------------------------------
Current Hash Table:
----------------------------------------------------------
Hash Table Contents:
Index 0: Customer ID: 052, Name: Caleb E, Address: C, Priority: 5, Delivery Status: In-Transit, Time: 10.0
Index 1: Customer ID: 053, Name: Eleanor F, Address: D, Priority: 4, Delivery Status: In-Transit, Time: 12.0
Index 2: Customer ID: 020, Name: Charlotte A, Address: E, Priority: 1, Delivery Status: In-Transit, Time: 9.0
Index 3: Customer ID: 021, Name: Harper B, Address: F, Priority: 2, Delivery Status: In-Transit, Time: 7.0
Index 4: Customer ID: 022, Name: Henry C, Address: G, Priority: 3, Delivery Status: In-Transit, Time: 8.0
Index 5: Customer ID: 023, Name: Evelyn D, Address: B, Priority: 4, Delivery Status: In-Transit, Time: 6.0
Index 6: Customer ID: 024, Name: Alexander E, Address: C, Priority: 5, Delivery Status: In-Transit, Time: 10.0
Index 7: Customer ID: 025, Name: Abigail F, Address: D, Priority: 4, Delivery Status: In-Transit, Time: 12.0
Index 8: Customer ID: 026, Name: Michael G, Address: A, Priority: 2, Delivery Status: In-Transit, Time: 5.0
Index 9: Customer ID: 027, Name: Emily A, Address: F, Priority: 1, Delivery Status: In-Transit, Time: 14.0
Index 10: Customer ID: 028, Name: Daniel B, Address: G, Priority: 2, Delivery Status: In-Transit, Time: 11.0
Index 11: Customer ID: 029, Name: Elizabeth C, Address: A, Priority: 3, Delivery Status: In-Transit, Time: 13.0
Index 12: Customer ID: 054, Name: Christian G, Address: A, Priority: 2, Delivery Status: In-Transit, Time: 5.0
Index 13: Customer ID: 055, Name: Nora A, Address: F, Priority: 1, Delivery Status: In-Transit, Time: 14.0
Index 14: Customer ID: 056, Name: Jonathan B, Address: G, Priority: 2, Delivery Status: In-Transit, Time: 11.0
Index 15: Customer ID: 057, Name: Penelope C, Address: A, Priority: 3, Delivery Status: In-Transit, Time: 13.0
Index 16: Customer ID: 058, Name: Thomas D, Address: E, Priority: 4, Delivery Status: In-Transit, Time: 9.0
Index 17: Customer ID: 059, Name: Zoey E, Address: B, Priority: 5, Delivery Status: In-Transit, Time: 8.0
Index 18: Empty
Index 19: Empty
Index 20: Empty
Index 21: Empty
Index 22: Empty
Index 23: Empty
Index 24: Empty
Index 25: Empty
Index 26: Empty
Index 27: Empty
Index 28: Empty
Index 29: Customer ID: 060, Name: Charles F, Address: C, Priority: 4, Delivery Status: In-Transit, Time: 7.0
Index 30: Empty
Index 31: Empty
Index 32: Empty
Index 33: Customer ID: 030, Name: Matthew D, Address: E, Priority: 4, Delivery Status: In-Transit, Time: 9.0
Index 34: Customer ID: 031, Name: Sofia E, Address: B, Priority: 5, Delivery Status: In-Transit, Time: 8.0
Index 35: Customer ID: 032, Name: David F, Address: C, Priority: 4, Delivery Status: In-Transit, Time: 7.0
Index 36: Customer ID: 033, Name: Scarlett G, Address: D, Priority: 2, Delivery Status: In-Transit, Time: 6.0
Index 37: Customer ID: 000, Name: John A, Address: B, Priority: 1, Delivery Status: In-Transit, Time: 10.0
Index 38: Customer ID: 001, Name: Daniel B, Address: E, Priority: 2, Delivery Status: In-Transit, Time: 2.0
Index 39: Customer ID: 002, Name: Sam C, Address: D, Priority: 3, Delivery Status: In-Transit, Time: 1.0
Index 40: Customer ID: 003, Name: Jo D, Address: F, Priority: 4, Delivery Status: In-Transit, Time: 11.0
Index 41: Customer ID: 004, Name: Robin F, Address: D, Priority: 5, Delivery Status: In-Transit, Time: 16.0
Index 42: Customer ID: 005, Name: Alex F, Address: G, Priority: 4, Delivery Status: In-Transit, Time: 23.0
Index 43: Customer ID: 006, Name: Chris A, Address: D, Priority: 1, Delivery Status: In-Transit, Time: 8.0
Index 44: Customer ID: 007, Name: Emma B, Address: C, Priority: 2, Delivery Status: In-Transit, Time: 3.0
Index 45: Customer ID: 008, Name: Liam C, Address: E, Priority: 3, Delivery Status: In-Transit, Time: 5.0
Index 46: Customer ID: 009, Name: Olivia D, Address: A, Priority: 4, Delivery Status: In-Transit, Time: 7.0
Index 47: Customer ID: 034, Name: Joseph A, Address: G, Priority: 1, Delivery Status: In-Transit, Time: 10.0
Index 48: Customer ID: 035, Name: Victoria B, Address: A, Priority: 2, Delivery Status: In-Transit, Time: 12.0
Index 49: Customer ID: 036, Name: Andrew C, Address: E, Priority: 3, Delivery Status: In-Transit, Time: 11.0
Index 50: Customer ID: 037, Name: Grace D, Address: F, Priority: 4, Delivery Status: In-Transit, Time: 15.0
Index 51: Customer ID: 038, Name: Joshua E, Address: G, Priority: 5, Delivery Status: In-Transit, Time: 14.0
Index 52: Customer ID: 039, Name: Zoey F, Address: A, Priority: 4, Delivery Status: In-Transit, Time: 13.0
Index 53: Empty
Index 54: Empty
Index 55: Empty
Index 56: Empty
Index 57: Empty
Index 58: Empty
Index 59: Empty
Index 60: Empty
Index 61: Empty
Index 62: Empty
Index 63: Empty
Index 64: Customer ID: 040, Name: Logan G, Address: B, Priority: 2, Delivery Status: In-Transit, Time: 9.0
Index 65: Customer ID: 041, Name: Chloe A, Address: C, Priority: 1, Delivery Status: In-Transit, Time: 8.0
Index 66: Customer ID: 042, Name: Jack B, Address: D, Priority: 2, Delivery Status: In-Transit, Time: 7.0
Index 67: Customer ID: 043, Name: Aria C, Address: F, Priority: 3, Delivery Status: In-Transit, Time: 6.0
Index 68: Customer ID: 010, Name: Noah E, Address: F, Priority: 5, Delivery Status: In-Transit, Time: 6.0
Index 69: Customer ID: 011, Name: Ava F, Address: G, Priority: 4, Delivery Status: In-Transit, Time: 9.0
Index 70: Customer ID: 012, Name: Isabella G, Address: E, Priority: 2, Delivery Status: In-Transit, Time: 12.0
Index 71: Customer ID: 013, Name: Mason A, Address: C, Priority: 1, Delivery Status: In-Transit, Time: 4.0
Index 72: Customer ID: 014, Name: Sophia B, Address: D, Priority: 2, Delivery Status: In-Transit, Time: 3.0
Index 73: Customer ID: 015, Name: James C, Address: F, Priority: 3, Delivery Status: In-Transit, Time: 10.0
Index 74: Customer ID: 016, Name: Mia D, Address: G, Priority: 4, Delivery Status: In-Transit, Time: 15.0
Index 75: Customer ID: 017, Name: Elijah E, Address: A, Priority: 5, Delivery Status: In-Transit, Time: 11.0
Index 76: Customer ID: 018, Name: Amelia F, Address: B, Priority: 4, Delivery Status: In-Transit, Time: 13.0
Index 77: Customer ID: 019, Name: Lucas G, Address: C, Priority: 2, Delivery Status: In-Transit, Time: 14.0
Index 78: Customer ID: 044, Name: Levi D, Address: G, Priority: 4, Delivery Status: In-Transit, Time: 5.0
Index 79: Customer ID: 045, Name: Lily E, Address: A, Priority: 5, Delivery Status: In-Transit, Time: 10.0
Index 80: Customer ID: 046, Name: Samuel F, Address: B, Priority: 4, Delivery Status: In-Transit, Time: 12.0
Index 81: Customer ID: 047, Name: Hannah G, Address: C, Priority: 2, Delivery Status: In-Transit, Time: 11.0
Index 82: Customer ID: 048, Name: Anthony A, Address: E, Priority: 1, Delivery Status: In-Transit, Time: 9.0
Index 83: Customer ID: 049, Name: Addison B, Address: F, Priority: 2, Delivery Status: In-Transit, Time: 8.0
Index 84: Empty
Index 85: Empty
Index 86: Empty
Index 87: Empty
Index 88: Empty
Index 89: Empty
Index 90: Empty
Index 91: Empty
Index 92: Empty
Index 93: Empty
Index 94: Empty
Index 95: Customer ID: 050, Name: Isaac C, Address: G, Priority: 3, Delivery Status: In-Transit, Time: 7.0
Index 96: Customer ID: 051, Name: Aubrey D, Address: B, Priority: 4, Delivery Status: In-Transit, Time: 6.0
```

Fig 2 – Loading CSV File with Test Customers into Hash Table with Output

```
===================================== Hash Based Customer Look Up =====================================
1. Add/Update Customer
2. Look Up Customer
3. Remove Customer
4. Check Customer Exists
5. Show Load Factor
6. Clear Hash Table
7. Load from CSV
8. Save to CSV
9. Collision Example
10. Display Hash Table
11. Load from Module Three
12. Back to Main Menu
Select option: 12

--- Delivery System Main Menu ---
1. Graph Based Route Planning
2. Hash Based Customer Look Up
3. Heap Based Parcel Scheduling
4. Sorting Delivery Records
5. Test Sorts
6. Exit
Select an option (1-5): 3

===================================== Heap Based Parcel Scheduling =====================================
1. Add Parcel
2. Remove Highest Priority Parcel (Delivered Package)
3. Display Heap
4. Load from CSV
5. Save to CSV
6. Load from Module Two
7. Save removed items to CSV
8. Back to Main Menu
Select option: 6
Data Loaded.

===================================== Heap Based Parcel Scheduling =====================================
1. Add Parcel
2. Remove Highest Priority Parcel (Delivered Package)
3. Display Heap
4. Load from CSV
5. Save to CSV
6. Load from Module Two
7. Save removed items to CSV
8. Back to Main Menu
Select option: 3
========================================================================
Current Heap:
========================================================================
Customer Name: 027, Customer ID: Emily A, Address: F, Priority (Calculated): 0.06999999999999999, Delivery Status: In-Transit, Time: 14.0
Customer Name: 034, Customer ID: Joseph A, Address: G, Priority (Calculated): 0.05, Delivery Status: In-Transit, Time: 10.0
Customer Name: 055, Customer ID: Nora A, Address: F, Priority (Calculated): 0.06999999999999999, Delivery Status: In-Transit, Time: 14.0
Customer Name: 035, Customer ID: Victoria B, Address: A, Priority (Calculated): 0.048, Delivery Status: In-Transit, Time: 12.0
Customer Name: 012, Customer ID: Isabella G, Address: E, Priority (Calculated): 0.048, Delivery Status: In-Transit, Time: 12.0
Customer Name: 019, Customer ID: Lucas G, Address: C, Priority (Calculated): 0.056, Delivery Status: In-Transit, Time: 14.0
Customer Name: 005, Customer ID: Alex F, Address: G, Priority (Calculated): 0.046, Delivery Status: In-Transit, Time: 23.0
Customer Name: 020, Customer ID: Charlotte A, Address: E, Priority (Calculated): 0.045, Delivery Status: In-Transit, Time: 9.0
Customer Name: 036, Customer ID: Andrew C, Address: E, Priority (Calculated): 0.033, Delivery Status: In-Transit, Time: 11.0
Customer Name: 041, Customer ID: Chloe A, Address: C, Priority (Calculated): 0.04, Delivery Status: In-Transit, Time: 8.0
Customer Name: 028, Customer ID: Daniel B, Address: G, Priority (Calculated): 0.044000000000000004, Delivery Status: In-Transit, Time: 11.0
Customer Name: 015, Customer ID: James C, Address: F, Priority (Calculated): 0.03, Delivery Status: In-Transit, Time: 10.0
Customer Name: 000, Customer ID: John A, Address: B, Priority (Calculated): 0.05, Delivery Status: In-Transit, Time: 10.0
Customer Name: 048, Customer ID: Anthony A, Address: E, Priority (Calculated): 0.045, Delivery Status: In-Transit, Time: 9.0
Customer Name: 006, Customer ID: Chris A, Address: D, Priority (Calculated): 0.04, Delivery Status: In-Transit, Time: 8.0
Customer Name: 008, Customer ID: Liam C, Address: E, Priority (Calculated): 0.015, Delivery Status: In-Transit, Time: 5.0
Customer Name: 057, Customer ID: Penelope C, Address: A, Priority (Calculated): 0.039, Delivery Status: In-Transit, Time: 13.0
Customer Name: 037, Customer ID: Grace D, Address: F, Priority (Calculated): 0.03, Delivery Status: In-Transit, Time: 15.0
Customer Name: 039, Customer ID: Zoey F, Address: A, Priority (Calculated): 0.026000000000000002, Delivery Status: In-Transit, Time: 13.0
Customer Name: 040, Customer ID: Logan G, Address: B, Priority (Calculated): 0.036, Delivery Status: In-Transit, Time: 9.0
Customer Name: 042, Customer ID: Jack B, Address: D, Priority (Calculated): 0.028, Delivery Status: In-Transit, Time: 7.0
Customer Name: 011, Customer ID: Ava F, Address: G, Priority (Calculated): 0.018, Delivery Status: In-Transit, Time: 9.0
Customer Name: 021, Customer ID: Harper B, Address: F, Priority (Calculated): 0.028, Delivery Status: In-Transit, Time: 7.0
Customer Name: 053, Customer ID: Eleanor F, Address: D, Priority (Calculated): 0.024, Delivery Status: In-Transit, Time: 12.0
Customer Name: 016, Customer ID: Mia D, Address: G, Priority (Calculated): 0.03, Delivery Status: In-Transit, Time: 15.0
Customer Name: 018, Customer ID: Amelia F, Address: B, Priority (Calculated): 0.026000000000000002, Delivery Status: In-Transit, Time: 13.0
Customer Name: 054, Customer ID: Christian G, Address: A, Priority (Calculated): 0.02, Delivery Status: In-Transit, Time: 5.0
Customer Name: 047, Customer ID: Hannah G, Address: C, Priority (Calculated): 0.044000000000000004, Delivery Status: In-Transit, Time: 11.0
Customer Name: 056, Customer ID: Jonathan B, Address: G, Priority (Calculated): 0.044000000000000004, Delivery Status: In-Transit, Time: 11.0
Customer Name: 029, Customer ID: Elizabeth C, Address: A, Priority (Calculated): 0.039, Delivery Status: In-Transit, Time: 13.0
Customer Name: 007, Customer ID: Emma B, Address: C, Priority (Calculated): 0.012, Delivery Status: In-Transit, Time: 3.0
Customer Name: 052, Customer ID: Caleb E, Address: C, Priority (Calculated): 0.01, Delivery Status: In-Transit, Time: 10.0
Customer Name: 009, Customer ID: Olivia D, Address: A, Priority (Calculated): 0.014, Delivery Status: In-Transit, Time: 7.0
Customer Name: 058, Customer ID: Thomas D, Address: E, Priority (Calculated): 0.018, Delivery Status: In-Transit, Time: 9.0
Customer Name: 025, Customer ID: Abigail F, Address: D, Priority (Calculated): 0.024, Delivery Status: In-Transit, Time: 12.0
Customer Name: 059, Customer ID: Zoey E, Address: B, Priority (Calculated): 0.008, Delivery Status: In-Transit, Time: 8.0
Customer Name: 026, Customer ID: Michael G, Address: A, Priority (Calculated): 0.02, Delivery Status: In-Transit, Time: 5.0
Customer Name: 038, Customer ID: Joshua E, Address: G, Priority (Calculated): 0.014, Delivery Status: In-Transit, Time: 14.0
Customer Name: 060, Customer ID: Charles F, Address: C, Priority (Calculated): 0.014, Delivery Status: In-Transit, Time: 7.0
Customer Name: 030, Customer ID: Matthew D, Address: E, Priority (Calculated): 0.018, Delivery Status: In-Transit, Time: 9.0
Customer Name: 022, Customer ID: Henry C, Address: G, Priority (Calculated): 0.024, Delivery Status: In-Transit, Time: 8.0
Customer Name: 031, Customer ID: Sofia E, Address: B, Priority (Calculated): 0.008, Delivery Status: In-Transit, Time: 8.0
Customer Name: 043, Customer ID: Aria C, Address: F, Priority (Calculated): 0.018000000000000002, Delivery Status: In-Transit, Time: 6.0
Customer Name: 010, Customer ID: Noah E, Address: F, Priority (Calculated): 0.006, Delivery Status: In-Transit, Time: 6.0
Customer Name: 032, Customer ID: David F, Address: C, Priority (Calculated): 0.014, Delivery Status: In-Transit, Time: 7.0
Customer Name: 033, Customer ID: Scarlett G, Address: D, Priority (Calculated): 0.024, Delivery Status: In-Transit, Time: 6.0
Customer Name: 013, Customer ID: Mason A, Address: C, Priority (Calculated): 0.02, Delivery Status: In-Transit, Time: 4.0
Customer Name: 014, Customer ID: Sophia B, Address: D, Priority (Calculated): 0.012, Delivery Status: In-Transit, Time: 3.0
Customer Name: 023, Customer ID: Evelyn D, Address: B, Priority (Calculated): 0.012, Delivery Status: In-Transit, Time: 6.0
Customer Name: 001, Customer ID: Daniel B, Address: E, Priority (Calculated): 0.008, Delivery Status: In-Transit, Time: 2.0
Customer Name: 017, Customer ID: Elijah E, Address: A, Priority (Calculated): 0.011000000000000001, Delivery Status: In-Transit, Time: 11.0
Customer Name: 002, Customer ID: Sam C, Address: D, Priority (Calculated): 0.003, Delivery Status: In-Transit, Time: 1.0
Customer Name: 003, Customer ID: Jo D, Address: F, Priority (Calculated): 0.022000000000000002, Delivery Status: In-Transit, Time: 11.0
Customer Name: 044, Customer ID: Levi D, Address: G, Priority (Calculated): 0.01, Delivery Status: In-Transit, Time: 5.0
Customer Name: 045, Customer ID: Lily E, Address: A, Priority (Calculated): 0.01, Delivery Status: In-Transit, Time: 10.0
Customer Name: 024, Customer ID: Alexander E, Address: C, Priority (Calculated): 0.01, Delivery Status: In-Transit, Time: 10.0
Customer Name: 046, Customer ID: Samuel F, Address: B, Priority (Calculated): 0.024, Delivery Status: In-Transit, Time: 12.0
Customer Name: 004, Customer ID: Robin F, Address: D, Priority (Calculated): 0.016, Delivery Status: In-Transit, Time: 16.0
Customer Name: 049, Customer ID: Addison B, Address: F, Priority (Calculated): 0.032, Delivery Status: In-Transit, Time: 8.0
Customer Name: 050, Customer ID: Isaac C, Address: G, Priority (Calculated): 0.020999999999999998, Delivery Status: In-Transit, Time: 7.0
Customer Name: 051, Customer ID: Aubrey D, Address: B, Priority (Calculated): 0.012, Delivery Status: In-Transit, Time: 6.0
```

Fig 3 – Raw Heap Output (Not a Sorted List Based on Priorities)



```
-------------------------------------- Heap Based Parcel Scheduling --------------------------------------
1. Add Parcel
2. Remove Highest Priority Parcel (Delivered Package)
3. Display Heap
4. Load from CSV
5. Save to CSV
6. Load from Module Two
7. Save removed items to CSV
8. Back to Main Menu
Select option: 3
----------------------------------------------------------------------
Current Heap:
----------------------------------------------------------------------
Heap is empty.

-------------------------------------- Heap Based Parcel Scheduling --------------------------------------
1. Add Parcel
2. Remove Highest Priority Parcel (Delivered Package)
3. Display Heap
4. Load from CSV
5. Save to CSV
6. Load from Module Two
7. Save removed items to CSV
8. Back to Main Menu
Select option: 4
Enter CSV filename to load: export.csv
Heap loaded from CSV.

-------------------------------------- Heap Based Parcel Scheduling --------------------------------------
1. Add Parcel
2. Remove Highest Priority Parcel (Delivered Package)
3. Display Heap
4. Load from CSV
5. Save to CSV
6. Load from Module Two
7. Save removed items to CSV
8. Back to Main Menu
Select option: 3
----------------------------------------------------------------------
Current Heap:
----------------------------------------------------------------------
Customer Name: 027, Customer ID: Emily A, Address: F, Priority (Calculated): 0.06999999999999999, Delivery Status: In-Transit, Time: 14.0
Customer Name: 055, Customer ID: Nora A, Address: F, Priority (Calculated): 0.06999999999999999, Delivery Status: In-Transit, Time: 14.0
Customer Name: 019, Customer ID: Lucas G, Address: C, Priority (Calculated): 0.056, Delivery Status: In-Transit, Time: 14.0
Customer Name: 000, Customer ID: John A, Address: B, Priority (Calculated): 0.05, Delivery Status: In-Transit, Time: 10.0
Customer Name: 034, Customer ID: Joseph A, Address: G, Priority (Calculated): 0.05, Delivery Status: In-Transit, Time: 10.0
Customer Name: 035, Customer ID: Victoria B, Address: A, Priority (Calculated): 0.048, Delivery Status: In-Transit, Time: 12.0
Customer Name: 012, Customer ID: Isabella G, Address: E, Priority (Calculated): 0.048, Delivery Status: In-Transit, Time: 12.0
Customer Name: 005, Customer ID: Alex F, Address: G, Priority (Calculated): 0.046, Delivery Status: In-Transit, Time: 23.0
Customer Name: 020, Customer ID: Charlotte A, Address: E, Priority (Calculated): 0.045, Delivery Status: In-Transit, Time: 9.0
Customer Name: 048, Customer ID: Anthony A, Address: E, Priority (Calculated): 0.045, Delivery Status: In-Transit, Time: 9.0
Customer Name: 047, Customer ID: Hannah G, Address: C, Priority (Calculated): 0.044000000000000004, Delivery Status: In-Transit, Time: 11.0
Customer Name: 028, Customer ID: Daniel B, Address: G, Priority (Calculated): 0.044000000000000004, Delivery Status: In-Transit, Time: 11.0
Customer Name: 056, Customer ID: Jonathan B, Address: G, Priority (Calculated): 0.044000000000000004, Delivery Status: In-Transit, Time: 11.0
Customer Name: 041, Customer ID: Chloe A, Address: C, Priority (Calculated): 0.04, Delivery Status: In-Transit, Time: 8.0
Customer Name: 006, Customer ID: Chris A, Address: D, Priority (Calculated): 0.04, Delivery Status: In-Transit, Time: 8.0
Customer Name: 057, Customer ID: Penelope C, Address: A, Priority (Calculated): 0.039, Delivery Status: In-Transit, Time: 13.0
Customer Name: 029, Customer ID: Elizabeth C, Address: A, Priority (Calculated): 0.039, Delivery Status: In-Transit, Time: 13.0
Customer Name: 040, Customer ID: Logan G, Address: B, Priority (Calculated): 0.036, Delivery Status: In-Transit, Time: 9.0
Customer Name: 036, Customer ID: Andrew C, Address: E, Priority (Calculated): 0.033, Delivery Status: In-Transit, Time: 11.0
Customer Name: 049, Customer ID: Addison B, Address: F, Priority (Calculated): 0.032, Delivery Status: In-Transit, Time: 8.0
Customer Name: 016, Customer ID: Mia D, Address: G, Priority (Calculated): 0.03, Delivery Status: In-Transit, Time: 15.0
Customer Name: 037, Customer ID: Grace D, Address: F, Priority (Calculated): 0.03, Delivery Status: In-Transit, Time: 15.0
Customer Name: 015, Customer ID: James C, Address: F, Priority (Calculated): 0.03, Delivery Status: In-Transit, Time: 10.0
Customer Name: 042, Customer ID: Jack B, Address: D, Priority (Calculated): 0.028, Delivery Status: In-Transit, Time: 7.0
Customer Name: 021, Customer ID: Harper B, Address: F, Priority (Calculated): 0.028, Delivery Status: In-Transit, Time: 7.0
Customer Name: 018, Customer ID: Amelia F, Address: B, Priority (Calculated): 0.026000000000000002, Delivery Status: In-Transit, Time: 13.0
Customer Name: 039, Customer ID: Zoey F, Address: A, Priority (Calculated): 0.026000000000000002, Delivery Status: In-Transit, Time: 13.0
Customer Name: 033, Customer ID: Scarlett G, Address: D, Priority (Calculated): 0.024, Delivery Status: In-Transit, Time: 6.0
Customer Name: 046, Customer ID: Samuel F, Address: B, Priority (Calculated): 0.024, Delivery Status: In-Transit, Time: 12.0
Customer Name: 022, Customer ID: Henry C, Address: G, Priority (Calculated): 0.024, Delivery Status: In-Transit, Time: 8.0
Customer Name: 025, Customer ID: Abigail F, Address: D, Priority (Calculated): 0.024, Delivery Status: In-Transit, Time: 12.0
Customer Name: 053, Customer ID: Eleanor F, Address: D, Priority (Calculated): 0.024, Delivery Status: In-Transit, Time: 12.0
Customer Name: 003, Customer ID: Jo D, Address: F, Priority (Calculated): 0.022000000000000002, Delivery Status: In-Transit, Time: 11.0
Customer Name: 050, Customer ID: Isaac C, Address: G, Priority (Calculated): 0.020999999999999998, Delivery Status: In-Transit, Time: 7.0
Customer Name: 026, Customer ID: Michael G, Address: A, Priority (Calculated): 0.02, Delivery Status: In-Transit, Time: 5.0
Customer Name: 054, Customer ID: Christian G, Address: A, Priority (Calculated): 0.02, Delivery Status: In-Transit, Time: 5.0
Customer Name: 013, Customer ID: Mason A, Address: C, Priority (Calculated): 0.02, Delivery Status: In-Transit, Time: 4.0
Customer Name: 043, Customer ID: Aria C, Address: F, Priority (Calculated): 0.018000000000000002, Delivery Status: In-Transit, Time: 6.0
Customer Name: 058, Customer ID: Thomas D, Address: E, Priority (Calculated): 0.018, Delivery Status: In-Transit, Time: 9.0
Customer Name: 011, Customer ID: Ava F, Address: G, Priority (Calculated): 0.018, Delivery Status: In-Transit, Time: 9.0
Customer Name: 030, Customer ID: Matthew D, Address: E, Priority (Calculated): 0.018, Delivery Status: In-Transit, Time: 9.0
Customer Name: 004, Customer ID: Robin F, Address: D, Priority (Calculated): 0.016, Delivery Status: In-Transit, Time: 16.0
Customer Name: 008, Customer ID: Liam C, Address: E, Priority (Calculated): 0.015, Delivery Status: In-Transit, Time: 5.0
Customer Name: 032, Customer ID: David F, Address: C, Priority (Calculated): 0.014, Delivery Status: In-Transit, Time: 7.0
Customer Name: 038, Customer ID: Joshua E, Address: G, Priority (Calculated): 0.014, Delivery Status: In-Transit, Time: 14.0
Customer Name: 060, Customer ID: Charles F, Address: C, Priority (Calculated): 0.014, Delivery Status: In-Transit, Time: 7.0
Customer Name: 009, Customer ID: Olivia D, Address: A, Priority (Calculated): 0.014, Delivery Status: In-Transit, Time: 7.0
Customer Name: 007, Customer ID: Emma B, Address: C, Priority (Calculated): 0.012, Delivery Status: In-Transit, Time: 3.0
Customer Name: 023, Customer ID: Evelyn D, Address: B, Priority (Calculated): 0.012, Delivery Status: In-Transit, Time: 6.0
Customer Name: 014, Customer ID: Sophia B, Address: D, Priority (Calculated): 0.012, Delivery Status: In-Transit, Time: 3.0
Customer Name: 051, Customer ID: Aubrey D, Address: B, Priority (Calculated): 0.012, Delivery Status: In-Transit, Time: 6.0
Customer Name: 017, Customer ID: Elijah E, Address: A, Priority (Calculated): 0.011000000000000001, Delivery Status: In-Transit, Time: 11.0
Customer Name: 045, Customer ID: Lily E, Address: A, Priority (Calculated): 0.01, Delivery Status: In-Transit, Time: 10.0
Customer Name: 024, Customer ID: Alexander E, Address: C, Priority (Calculated): 0.01, Delivery Status: In-Transit, Time: 10.0
Customer Name: 052, Customer ID: Caleb E, Address: C, Priority (Calculated): 0.01, Delivery Status: In-Transit, Time: 10.0
Customer Name: 044, Customer ID: Levi D, Address: G, Priority (Calculated): 0.01, Delivery Status: In-Transit, Time: 5.0
Customer Name: 031, Customer ID: Sofia E, Address: B, Priority (Calculated): 0.008, Delivery Status: In-Transit, Time: 8.0
Customer Name: 059, Customer ID: Zoey E, Address: B, Priority (Calculated): 0.008, Delivery Status: In-Transit, Time: 8.0
Customer Name: 001, Customer ID: Daniel B, Address: E, Priority (Calculated): 0.008, Delivery Status: In-Transit, Time: 2.0
Customer Name: 010, Customer ID: Noah E, Address: F, Priority (Calculated): 0.006, Delivery Status: In-Transit, Time: 6.0
Customer Name: 002, Customer ID: Sam C, Address: D, Priority (Calculated): 0.003, Delivery Status: In-Transit, Time: 1.0
```

Fig 4 – Removing Items from Heap Until Empty Message Shows Up Followed by Exporting Removed Heap Items as CSV then Reimporting Them for Sorting

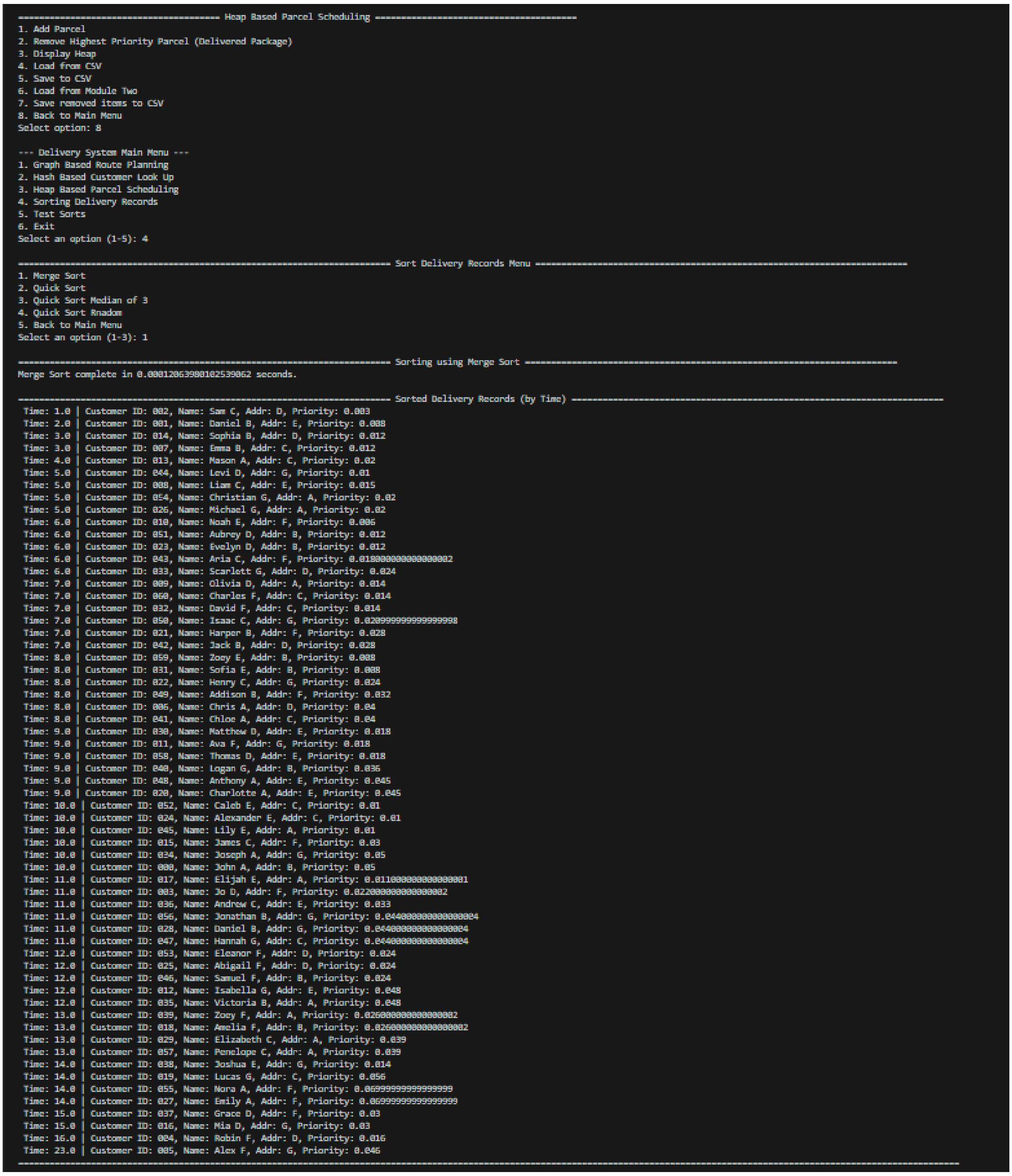
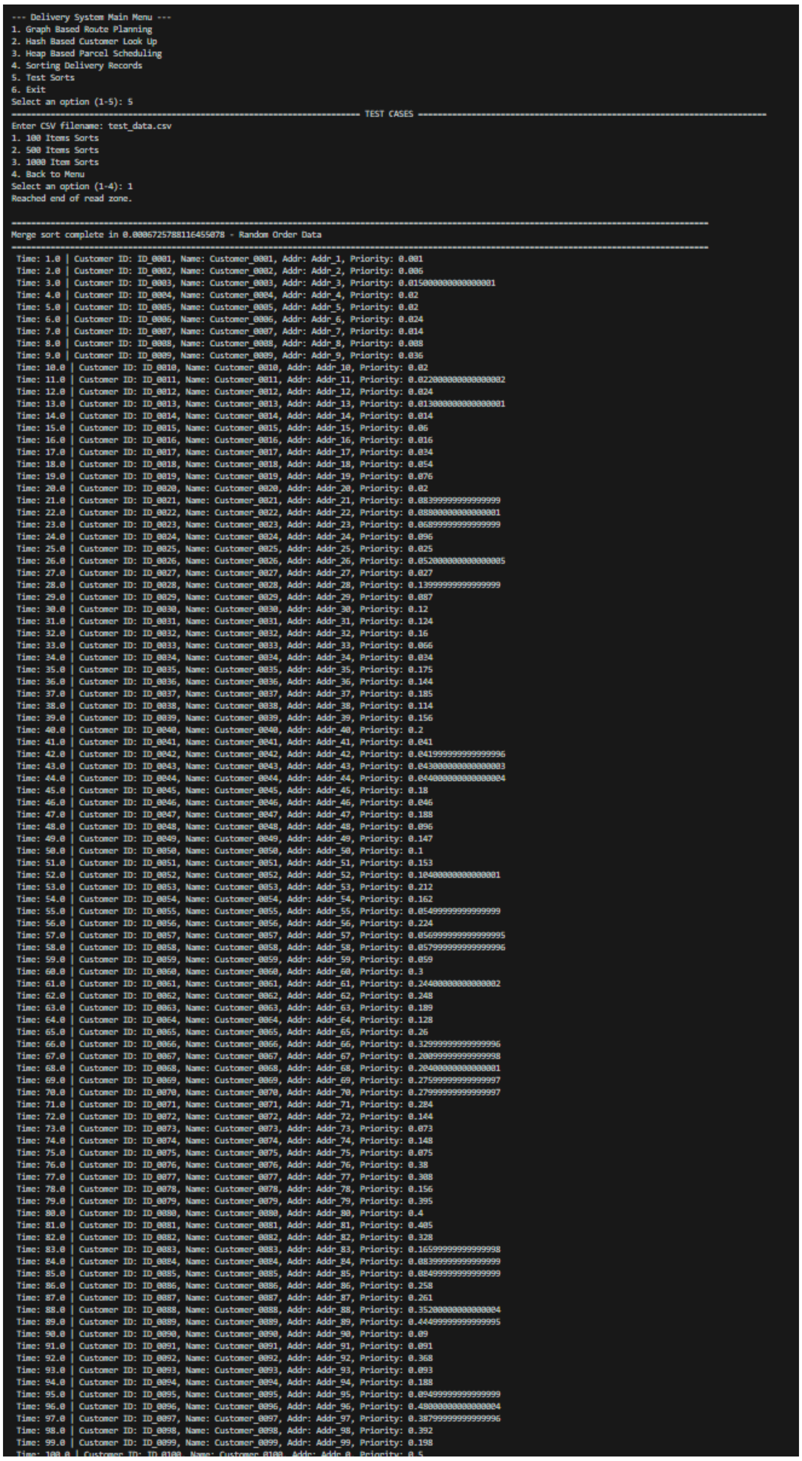


Fig 5 – Returning to Main Menu and Performing Merge Sort with Time Output

```
======================================================================== Sort Delivery Records Menu ========================================================================
1. Merge Sort
2. Quick Sort
3. Quick Sort Median of 3
4. Quick Sort Rnadom
5. Back to Main Menu
Select an option (1-3): 2

======================================================================== Sorting using Quick Sort ========================================================================
Quick Sort complete in 0.0003423690795898438 seconds.

======================================================================== Sorted Delivery Records (by Time) ========================================================================
 Time: 1.0 | Customer ID: 002, Name: Sam C, Addr: D, Priority: 0.003
 Time: 2.0 | Customer ID: 001, Name: Daniel B, Addr: E, Priority: 0.008
 Time: 3.0 | Customer ID: 014, Name: Sophia B, Addr: D, Priority: 0.012
 Time: 3.0 | Customer ID: 007, Name: Emma B, Addr: C, Priority: 0.012
 Time: 4.0 | Customer ID: 013, Name: Mason A, Addr: C, Priority: 0.02
 Time: 5.0 | Customer ID: 026, Name: Michael G, Addr: A, Priority: 0.02
 Time: 5.0 | Customer ID: 054, Name: Christian G, Addr: A, Priority: 0.02
 Time: 5.0 | Customer ID: 044, Name: Levi D, Addr: G, Priority: 0.01
 Time: 5.0 | Customer ID: 008, Name: Liam C, Addr: E, Priority: 0.015
 Time: 6.0 | Customer ID: 010, Name: Noah E, Addr: F, Priority: 0.006
 Time: 6.0 | Customer ID: 033, Name: Scarlett G, Addr: D, Priority: 0.024
 Time: 6.0 | Customer ID: 043, Name: Aria C, Addr: F, Priority: 0.018000000000000002
 Time: 6.0 | Customer ID: 023, Name: Evelyn D, Addr: B, Priority: 0.012
 Time: 6.0 | Customer ID: 051, Name: Aubrey D, Addr: B, Priority: 0.012
 Time: 7.0 | Customer ID: 021, Name: Harper B, Addr: F, Priority: 0.028
 Time: 7.0 | Customer ID: 060, Name: Charles F, Addr: C, Priority: 0.014
 Time: 7.0 | Customer ID: 009, Name: Olivia D, Addr: A, Priority: 0.014
 Time: 7.0 | Customer ID: 050, Name: Isaac C, Addr: G, Priority: 0.020999999999999998
 Time: 7.0 | Customer ID: 042, Name: Jack B, Addr: D, Priority: 0.028
 Time: 7.0 | Customer ID: 032, Name: David F, Addr: C, Priority: 0.014
 Time: 8.0 | Customer ID: 022, Name: Henry C, Addr: G, Priority: 0.024
 Time: 8.0 | Customer ID: 006, Name: Chris A, Addr: D, Priority: 0.04
 Time: 8.0 | Customer ID: 041, Name: Chloe A, Addr: C, Priority: 0.04
 Time: 8.0 | Customer ID: 049, Name: Addison B, Addr: F, Priority: 0.032
 Time: 8.0 | Customer ID: 031, Name: Sofia E, Addr: B, Priority: 0.008
 Time: 8.0 | Customer ID: 059, Name: Zoey E, Addr: B, Priority: 0.008
 Time: 9.0 | Customer ID: 048, Name: Anthony A, Addr: E, Priority: 0.045
 Time: 9.0 | Customer ID: 011, Name: Ava F, Addr: G, Priority: 0.018
 Time: 9.0 | Customer ID: 030, Name: Matthew D, Addr: E, Priority: 0.018
 Time: 9.0 | Customer ID: 040, Name: Logan G, Addr: B, Priority: 0.036
 Time: 9.0 | Customer ID: 058, Name: Thomas D, Addr: E, Priority: 0.018
 Time: 9.0 | Customer ID: 020, Name: Charlotte A, Addr: E, Priority: 0.045
 Time: 10.0 | Customer ID: 000, Name: John A, Addr: B, Priority: 0.05
 Time: 10.0 | Customer ID: 015, Name: James C, Addr: F, Priority: 0.03
 Time: 10.0 | Customer ID: 034, Name: Joseph A, Addr: G, Priority: 0.05
 Time: 10.0 | Customer ID: 045, Name: Lily E, Addr: A, Priority: 0.01
 Time: 10.0 | Customer ID: 024, Name: Alexander E, Addr: C, Priority: 0.01
 Time: 10.0 | Customer ID: 052, Name: Caleb E, Addr: C, Priority: 0.01
 Time: 11.0 | Customer ID: 028, Name: Daniel B, Addr: G, Priority: 0.044000000000000004
 Time: 11.0 | Customer ID: 047, Name: Hannah G, Addr: C, Priority: 0.044000000000000004
 Time: 11.0 | Customer ID: 003, Name: Jo D, Addr: F, Priority: 0.022000000000000002
 Time: 11.0 | Customer ID: 017, Name: Elijah E, Addr: A, Priority: 0.011000000000000001
 Time: 11.0 | Customer ID: 056, Name: Jonathan B, Addr: G, Priority: 0.044000000000000004
 Time: 11.0 | Customer ID: 036, Name: Andrew C, Addr: E, Priority: 0.033
 Time: 12.0 | Customer ID: 046, Name: Samuel F, Addr: B, Priority: 0.024
 Time: 12.0 | Customer ID: 053, Name: Eleanor F, Addr: D, Priority: 0.024
 Time: 12.0 | Customer ID: 025, Name: Abigail F, Addr: D, Priority: 0.024
 Time: 12.0 | Customer ID: 035, Name: Victoria B, Addr: A, Priority: 0.048
 Time: 12.0 | Customer ID: 012, Name: Isabella G, Addr: E, Priority: 0.048
 Time: 13.0 | Customer ID: 018, Name: Amelia F, Addr: B, Priority: 0.026000000000000002
 Time: 13.0 | Customer ID: 039, Name: Zoey F, Addr: A, Priority: 0.026000000000000002
 Time: 13.0 | Customer ID: 057, Name: Penelope C, Addr: A, Priority: 0.039
 Time: 13.0 | Customer ID: 029, Name: Elizabeth C, Addr: A, Priority: 0.039
 Time: 14.0 | Customer ID: 027, Name: Emily A, Addr: F, Priority: 0.06999999999999999
 Time: 14.0 | Customer ID: 055, Name: Nora A, Addr: F, Priority: 0.06999999999999999
 Time: 14.0 | Customer ID: 038, Name: Joshua E, Addr: G, Priority: 0.014
 Time: 14.0 | Customer ID: 019, Name: Lucas G, Addr: C, Priority: 0.056
 Time: 15.0 | Customer ID: 016, Name: Mia D, Addr: G, Priority: 0.03
 Time: 15.0 | Customer ID: 037, Name: Grace D, Addr: F, Priority: 0.03
 Time: 16.0 | Customer ID: 004, Name: Robin F, Addr: D, Priority: 0.016
 Time: 23.0 | Customer ID: 005, Name: Alex F, Addr: G, Priority: 0.046
==========================================================================================================================================================================
```

Fig 6 – Performing Quick Sort with Time Output

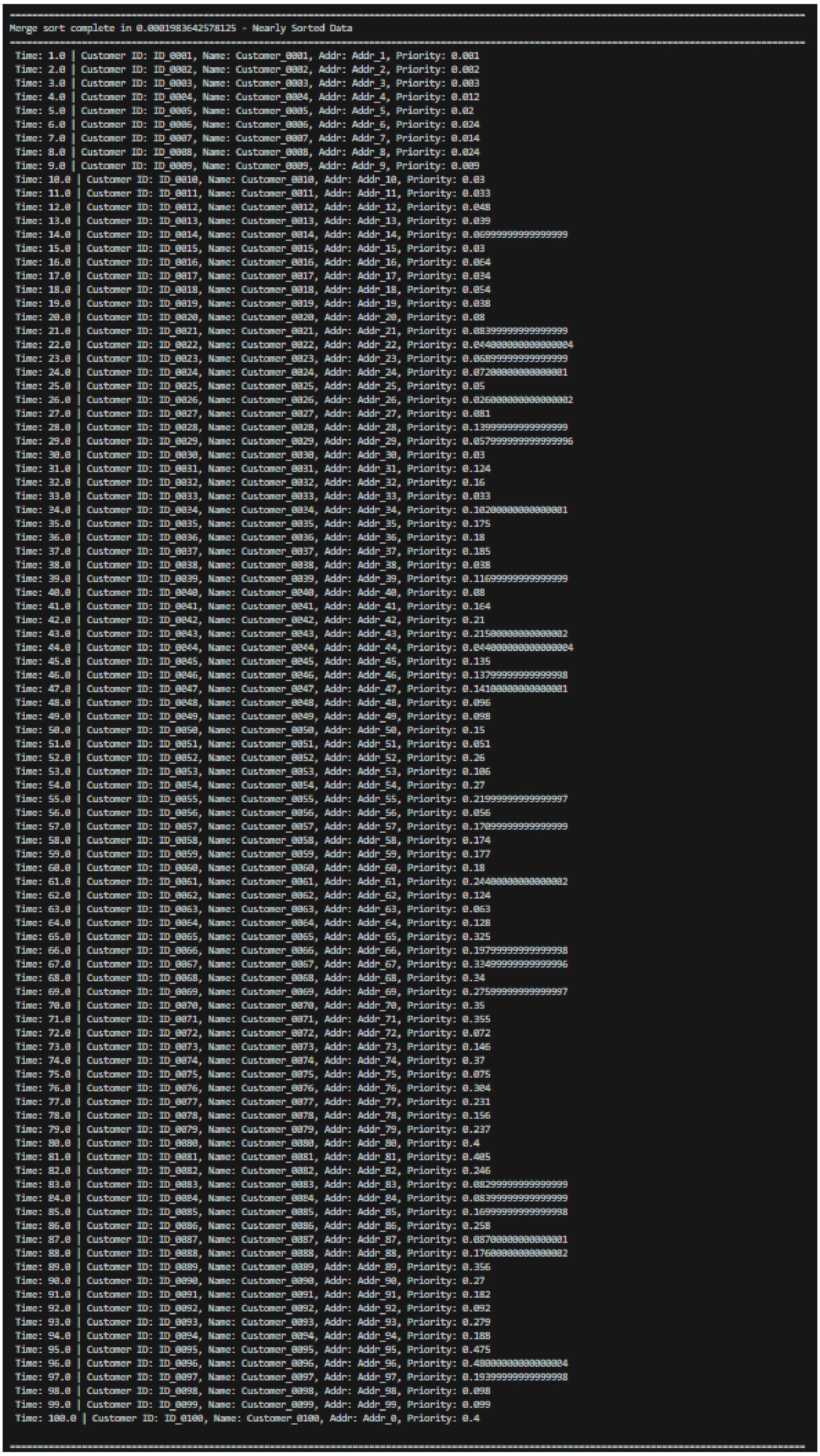


```
--- Delivery System Main Menu ---
1. Graph Based Route Planning
2. Hash Based Customer Look Up
3. Heap Based Parcel Scheduling
4. Sorting Delivery Records
5. Test Sorts
6. Exit
Select an option (1-5): 5
------------------------------------------------------------------------ TEST CASES ------------------------------------------------------------------------
Enter CSV filename: test_data.csv
1. 100 Items Sorts
2. 500 Items Sorts
3. 1000 Item Sorts
4. Back to Menu
Select an option (1-4): 1
Reached end of read zone.

--------------------------------------------------------------------------------------------------------------------------------------------
Merge sort complete in 0.0006725788116455078 - Random Order Data
--------------------------------------------------------------------------------------------------------------------------------------------
 Time: 1.0 | Customer ID: ID_0001, Name: Customer_0001, Addr: Addr_1, Priority: 0.001
 Time: 2.0 | Customer ID: ID_0002, Name: Customer_0002, Addr: Addr_2, Priority: 0.006
 Time: 3.0 | Customer ID: ID_0003, Name: Customer_0003, Addr: Addr_3, Priority: 0.015000000000000001
 Time: 4.0 | Customer ID: ID_0004, Name: Customer_0004, Addr: Addr_4, Priority: 0.02
 Time: 5.0 | Customer ID: ID_0005, Name: Customer_0005, Addr: Addr_5, Priority: 0.02
 Time: 6.0 | Customer ID: ID_0006, Name: Customer_0006, Addr: Addr_6, Priority: 0.024
 Time: 7.0 | Customer ID: ID_0007, Name: Customer_0007, Addr: Addr_7, Priority: 0.014
 Time: 8.0 | Customer ID: ID_0008, Name: Customer_0008, Addr: Addr_8, Priority: 0.008
 Time: 9.0 | Customer ID: ID_0009, Name: Customer_0009, Addr: Addr_9, Priority: 0.036
 Time: 10.0 | Customer ID: ID_0010, Name: Customer_0010, Addr: Addr_10, Priority: 0.02
 Time: 11.0 | Customer ID: ID_0011, Name: Customer_0011, Addr: Addr_11, Priority: 0.022000000000000002
 Time: 12.0 | Customer ID: ID_0012, Name: Customer_0012, Addr: Addr_12, Priority: 0.024
 Time: 13.0 | Customer ID: ID_0013, Name: Customer_0013, Addr: Addr_13, Priority: 0.013000000000000001
 Time: 14.0 | Customer ID: ID_0014, Name: Customer_0014, Addr: Addr_14, Priority: 0.014
 Time: 15.0 | Customer ID: ID_0015, Name: Customer_0015, Addr: Addr_15, Priority: 0.06
 Time: 16.0 | Customer ID: ID_0016, Name: Customer_0016, Addr: Addr_16, Priority: 0.016
 Time: 17.0 | Customer ID: ID_0017, Name: Customer_0017, Addr: Addr_17, Priority: 0.034
 Time: 18.0 | Customer ID: ID_0018, Name: Customer_0018, Addr: Addr_18, Priority: 0.054
 Time: 19.0 | Customer ID: ID_0019, Name: Customer_0019, Addr: Addr_19, Priority: 0.076
 Time: 20.0 | Customer ID: ID_0020, Name: Customer_0020, Addr: Addr_20, Priority: 0.02
 Time: 21.0 | Customer ID: ID_0021, Name: Customer_0021, Addr: Addr_21, Priority: 0.08399999999999999
 Time: 22.0 | Customer ID: ID_0022, Name: Customer_0022, Addr: Addr_22, Priority: 0.08800000000000001
 Time: 23.0 | Customer ID: ID_0023, Name: Customer_0023, Addr: Addr_23, Priority: 0.06899999999999999
 Time: 24.0 | Customer ID: ID_0024, Name: Customer_0024, Addr: Addr_24, Priority: 0.096
 Time: 25.0 | Customer ID: ID_0025, Name: Customer_0025, Addr: Addr_25, Priority: 0.025
 Time: 26.0 | Customer ID: ID_0026, Name: Customer_0026, Addr: Addr_26, Priority: 0.052000000000000005
 Time: 27.0 | Customer ID: ID_0027, Name: Customer_0027, Addr: Addr_27, Priority: 0.027
 Time: 28.0 | Customer ID: ID_0028, Name: Customer_0028, Addr: Addr_28, Priority: 0.13999999999999999
 Time: 29.0 | Customer ID: ID_0029, Name: Customer_0029, Addr: Addr_29, Priority: 0.087
 Time: 30.0 | Customer ID: ID_0030, Name: Customer_0030, Addr: Addr_30, Priority: 0.12
 Time: 31.0 | Customer ID: ID_0031, Name: Customer_0031, Addr: Addr_31, Priority: 0.124
 Time: 32.0 | Customer ID: ID_0032, Name: Customer_0032, Addr: Addr_32, Priority: 0.16
 Time: 33.0 | Customer ID: ID_0033, Name: Customer_0033, Addr: Addr_33, Priority: 0.066
 Time: 34.0 | Customer ID: ID_0034, Name: Customer_0034, Addr: Addr_34, Priority: 0.034
 Time: 35.0 | Customer ID: ID_0035, Name: Customer_0035, Addr: Addr_35, Priority: 0.175
 Time: 36.0 | Customer ID: ID_0036, Name: Customer_0036, Addr: Addr_36, Priority: 0.144
 Time: 37.0 | Customer ID: ID_0037, Name: Customer_0037, Addr: Addr_37, Priority: 0.185
 Time: 38.0 | Customer ID: ID_0038, Name: Customer_0038, Addr: Addr_38, Priority: 0.114
 Time: 39.0 | Customer ID: ID_0039, Name: Customer_0039, Addr: Addr_39, Priority: 0.156
 Time: 40.0 | Customer ID: ID_0040, Name: Customer_0040, Addr: Addr_40, Priority: 0.2
 Time: 41.0 | Customer ID: ID_0041, Name: Customer_0041, Addr: Addr_41, Priority: 0.041
 Time: 42.0 | Customer ID: ID_0042, Name: Customer_0042, Addr: Addr_42, Priority: 0.041999999999999996
 Time: 43.0 | Customer ID: ID_0043, Name: Customer_0043, Addr: Addr_43, Priority: 0.043000000000000003
 Time: 44.0 | Customer ID: ID_0044, Name: Customer_0044, Addr: Addr_44, Priority: 0.044000000000000004
 Time: 45.0 | Customer ID: ID_0045, Name: Customer_0045, Addr: Addr_45, Priority: 0.18
 Time: 46.0 | Customer ID: ID_0046, Name: Customer_0046, Addr: Addr_46, Priority: 0.046
 Time: 47.0 | Customer ID: ID_0047, Name: Customer_0047, Addr: Addr_47, Priority: 0.188
 Time: 48.0 | Customer ID: ID_0048, Name: Customer_0048, Addr: Addr_48, Priority: 0.096
 Time: 49.0 | Customer ID: ID_0049, Name: Customer_0049, Addr: Addr_49, Priority: 0.147
 Time: 50.0 | Customer ID: ID_0050, Name: Customer_0050, Addr: Addr_50, Priority: 0.1
 Time: 51.0 | Customer ID: ID_0051, Name: Customer_0051, Addr: Addr_51, Priority: 0.153
 Time: 52.0 | Customer ID: ID_0052, Name: Customer_0052, Addr: Addr_52, Priority: 0.10400000000000001
 Time: 53.0 | Customer ID: ID_0053, Name: Customer_0053, Addr: Addr_53, Priority: 0.212
 Time: 54.0 | Customer ID: ID_0054, Name: Customer_0054, Addr: Addr_54, Priority: 0.162
 Time: 55.0 | Customer ID: ID_0055, Name: Customer_0055, Addr: Addr_55, Priority: 0.05499999999999999
 Time: 56.0 | Customer ID: ID_0056, Name: Customer_0056, Addr: Addr_56, Priority: 0.224
 Time: 57.0 | Customer ID: ID_0057, Name: Customer_0057, Addr: Addr_57, Priority: 0.056999999999999995
 Time: 58.0 | Customer ID: ID_0058, Name: Customer_0058, Addr: Addr_58, Priority: 0.057999999999999996
 Time: 59.0 | Customer ID: ID_0059, Name: Customer_0059, Addr: Addr_59, Priority: 0.059
 Time: 60.0 | Customer ID: ID_0060, Name: Customer_0060, Addr: Addr_60, Priority: 0.3
 Time: 61.0 | Customer ID: ID_0061, Name: Customer_0061, Addr: Addr_61, Priority: 0.24400000000000002
 Time: 62.0 | Customer ID: ID_0062, Name: Customer_0062, Addr: Addr_62, Priority: 0.248
 Time: 63.0 | Customer ID: ID_0063, Name: Customer_0063, Addr: Addr_63, Priority: 0.189
 Time: 64.0 | Customer ID: ID_0064, Name: Customer_0064, Addr: Addr_64, Priority: 0.128
 Time: 65.0 | Customer ID: ID_0065, Name: Customer_0065, Addr: Addr_65, Priority: 0.26
 Time: 66.0 | Customer ID: ID_0066, Name: Customer_0066, Addr: Addr_66, Priority: 0.32999999999999996
 Time: 67.0 | Customer ID: ID_0067, Name: Customer_0067, Addr: Addr_67, Priority: 0.20999999999999998
 Time: 68.0 | Customer ID: ID_0068, Name: Customer_0068, Addr: Addr_68, Priority: 0.20400000000000001
 Time: 69.0 | Customer ID: ID_0069, Name: Customer_0069, Addr: Addr_69, Priority: 0.27599999999999997
 Time: 70.0 | Customer ID: ID_0070, Name: Customer_0070, Addr: Addr_70, Priority: 0.27999999999999997
 Time: 71.0 | Customer ID: ID_0071, Name: Customer_0071, Addr: Addr_71, Priority: 0.284
 Time: 72.0 | Customer ID: ID_0072, Name: Customer_0072, Addr: Addr_72, Priority: 0.144
 Time: 73.0 | Customer ID: ID_0073, Name: Customer_0073, Addr: Addr_73, Priority: 0.073
 Time: 74.0 | Customer ID: ID_0074, Name: Customer_0074, Addr: Addr_74, Priority: 0.148
 Time: 75.0 | Customer ID: ID_0075, Name: Customer_0075, Addr: Addr_75, Priority: 0.075
 Time: 76.0 | Customer ID: ID_0076, Name: Customer_0076, Addr: Addr_76, Priority: 0.38
 Time: 77.0 | Customer ID: ID_0077, Name: Customer_0077, Addr: Addr_77, Priority: 0.308
 Time: 78.0 | Customer ID: ID_0078, Name: Customer_0078, Addr: Addr_78, Priority: 0.156
 Time: 79.0 | Customer ID: ID_0079, Name: Customer_0079, Addr: Addr_79, Priority: 0.395
 Time: 80.0 | Customer ID: ID_0080, Name: Customer_0080, Addr: Addr_80, Priority: 0.4
 Time: 81.0 | Customer ID: ID_0081, Name: Customer_0081, Addr: Addr_81, Priority: 0.405
 Time: 82.0 | Customer ID: ID_0082, Name: Customer_0082, Addr: Addr_82, Priority: 0.328
 Time: 83.0 | Customer ID: ID_0083, Name: Customer_0083, Addr: Addr_83, Priority: 0.16599999999999998
 Time: 84.0 | Customer ID: ID_0084, Name: Customer_0084, Addr: Addr_84, Priority: 0.08399999999999999
 Time: 85.0 | Customer ID: ID_0085, Name: Customer_0085, Addr: Addr_85, Priority: 0.08499999999999999
 Time: 86.0 | Customer ID: ID_0086, Name: Customer_0086, Addr: Addr_86, Priority: 0.258
 Time: 87.0 | Customer ID: ID_0087, Name: Customer_0087, Addr: Addr_87, Priority: 0.261
 Time: 88.0 | Customer ID: ID_0088, Name: Customer_0088, Addr: Addr_88, Priority: 0.35200000000000004
 Time: 89.0 | Customer ID: ID_0089, Name: Customer_0089, Addr: Addr_89, Priority: 0.44499999999999995
 Time: 90.0 | Customer ID: ID_0090, Name: Customer_0090, Addr: Addr_90, Priority: 0.09
 Time: 91.0 | Customer ID: ID_0091, Name: Customer_0091, Addr: Addr_91, Priority: 0.091
 Time: 92.0 | Customer ID: ID_0092, Name: Customer_0092, Addr: Addr_92, Priority: 0.368
 Time: 93.0 | Customer ID: ID_0093, Name: Customer_0093, Addr: Addr_93, Priority: 0.093
 Time: 94.0 | Customer ID: ID_0094, Name: Customer_0094, Addr: Addr_94, Priority: 0.188
 Time: 95.0 | Customer ID: ID_0095, Name: Customer_0095, Addr: Addr_95, Priority: 0.09499999999999999
 Time: 96.0 | Customer ID: ID_0096, Name: Customer_0096, Addr: Addr_96, Priority: 0.48000000000000004
 Time: 97.0 | Customer ID: ID_0097, Name: Customer_0097, Addr: Addr_97, Priority: 0.38799999999999996
 Time: 98.0 | Customer ID: ID_0098, Name: Customer_0098, Addr: Addr_98, Priority: 0.392
 Time: 99.0 | Customer ID: ID_0099, Name: Customer_0099, Addr: Addr_99, Priority: 0.198
 Time: 100.0 | Customer ID: ID_0100, Name: Customer_0100, Addr: Addr_0, Priority: 0.5
```

Fig 7 – 100 Element Merge Sort Random Data with Time

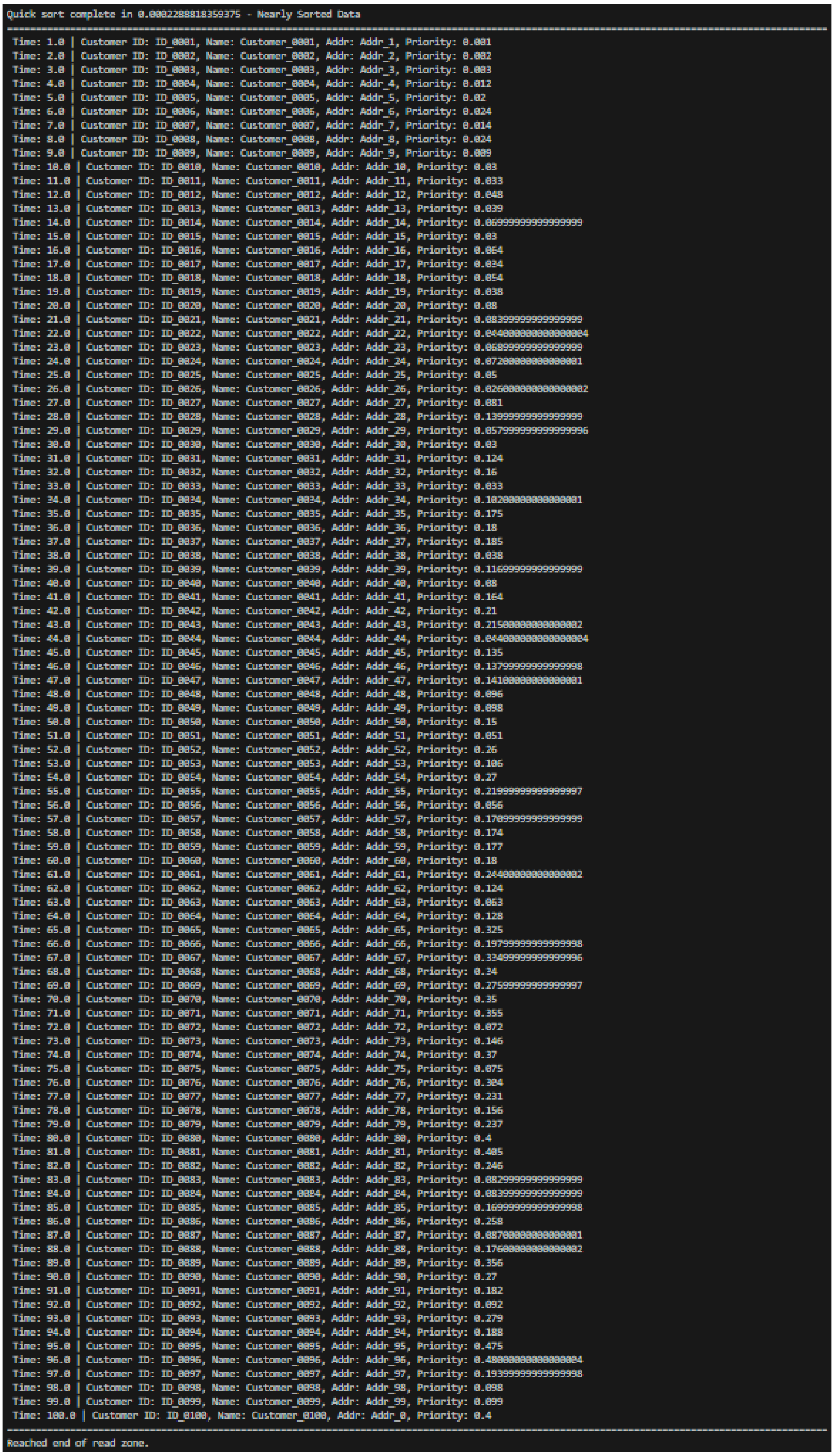
```
------------------------------------------------------------------------------------------------------------------------
Quick sort complete in 0.0007495880126953125 - Random Order Data
------------------------------------------------------------------------------------------------------------------------
 Time: 1.0 | Customer ID: ID_0001, Name: Customer_0001, Addr: Addr_1, Priority: 0.001
 Time: 2.0 | Customer ID: ID_0002, Name: Customer_0002, Addr: Addr_2, Priority: 0.006
 Time: 3.0 | Customer ID: ID_0003, Name: Customer_0003, Addr: Addr_3, Priority: 0.015000000000000001
 Time: 4.0 | Customer ID: ID_0004, Name: Customer_0004, Addr: Addr_4, Priority: 0.02
 Time: 5.0 | Customer ID: ID_0005, Name: Customer_0005, Addr: Addr_5, Priority: 0.02
 Time: 6.0 | Customer ID: ID_0006, Name: Customer_0006, Addr: Addr_6, Priority: 0.024
 Time: 7.0 | Customer ID: ID_0007, Name: Customer_0007, Addr: Addr_7, Priority: 0.014
 Time: 8.0 | Customer ID: ID_0008, Name: Customer_0008, Addr: Addr_8, Priority: 0.008
 Time: 9.0 | Customer ID: ID_0009, Name: Customer_0009, Addr: Addr_9, Priority: 0.036
 Time: 10.0 | Customer ID: ID_0010, Name: Customer_0010, Addr: Addr_10, Priority: 0.02
 Time: 11.0 | Customer ID: ID_0011, Name: Customer_0011, Addr: Addr_11, Priority: 0.022000000000000002
 Time: 12.0 | Customer ID: ID_0012, Name: Customer_0012, Addr: Addr_12, Priority: 0.024
 Time: 13.0 | Customer ID: ID_0013, Name: Customer_0013, Addr: Addr_13, Priority: 0.013000000000000001
 Time: 14.0 | Customer ID: ID_0014, Name: Customer_0014, Addr: Addr_14, Priority: 0.014
 Time: 15.0 | Customer ID: ID_0015, Name: Customer_0015, Addr: Addr_15, Priority: 0.06
 Time: 16.0 | Customer ID: ID_0016, Name: Customer_0016, Addr: Addr_16, Priority: 0.016
 Time: 17.0 | Customer ID: ID_0017, Name: Customer_0017, Addr: Addr_17, Priority: 0.034
 Time: 18.0 | Customer ID: ID_0018, Name: Customer_0018, Addr: Addr_18, Priority: 0.054
 Time: 19.0 | Customer ID: ID_0019, Name: Customer_0019, Addr: Addr_19, Priority: 0.076
 Time: 20.0 | Customer ID: ID_0020, Name: Customer_0020, Addr: Addr_20, Priority: 0.02
 Time: 21.0 | Customer ID: ID_0021, Name: Customer_0021, Addr: Addr_21, Priority: 0.08399999999999999
 Time: 22.0 | Customer ID: ID_0022, Name: Customer_0022, Addr: Addr_22, Priority: 0.08800000000000001
 Time: 23.0 | Customer ID: ID_0023, Name: Customer_0023, Addr: Addr_23, Priority: 0.06899999999999999
 Time: 24.0 | Customer ID: ID_0024, Name: Customer_0024, Addr: Addr_24, Priority: 0.096
 Time: 25.0 | Customer ID: ID_0025, Name: Customer_0025, Addr: Addr_25, Priority: 0.025
 Time: 26.0 | Customer ID: ID_0026, Name: Customer_0026, Addr: Addr_26, Priority: 0.052000000000000005
 Time: 27.0 | Customer ID: ID_0027, Name: Customer_0027, Addr: Addr_27, Priority: 0.027
 Time: 28.0 | Customer ID: ID_0028, Name: Customer_0028, Addr: Addr_28, Priority: 0.13999999999999999
 Time: 29.0 | Customer ID: ID_0029, Name: Customer_0029, Addr: Addr_29, Priority: 0.087
 Time: 30.0 | Customer ID: ID_0030, Name: Customer_0030, Addr: Addr_30, Priority: 0.12
 Time: 31.0 | Customer ID: ID_0031, Name: Customer_0031, Addr: Addr_31, Priority: 0.124
 Time: 32.0 | Customer ID: ID_0032, Name: Customer_0032, Addr: Addr_32, Priority: 0.16
 Time: 33.0 | Customer ID: ID_0033, Name: Customer_0033, Addr: Addr_33, Priority: 0.066
 Time: 34.0 | Customer ID: ID_0034, Name: Customer_0034, Addr: Addr_34, Priority: 0.034
 Time: 35.0 | Customer ID: ID_0035, Name: Customer_0035, Addr: Addr_35, Priority: 0.175
 Time: 36.0 | Customer ID: ID_0036, Name: Customer_0036, Addr: Addr_36, Priority: 0.144
 Time: 37.0 | Customer ID: ID_0037, Name: Customer_0037, Addr: Addr_37, Priority: 0.185
 Time: 38.0 | Customer ID: ID_0038, Name: Customer_0038, Addr: Addr_38, Priority: 0.114
 Time: 39.0 | Customer ID: ID_0039, Name: Customer_0039, Addr: Addr_39, Priority: 0.156
 Time: 40.0 | Customer ID: ID_0040, Name: Customer_0040, Addr: Addr_40, Priority: 0.2
 Time: 41.0 | Customer ID: ID_0041, Name: Customer_0041, Addr: Addr_41, Priority: 0.041
 Time: 42.0 | Customer ID: ID_0042, Name: Customer_0042, Addr: Addr_42, Priority: 0.041999999999999996
 Time: 43.0 | Customer ID: ID_0043, Name: Customer_0043, Addr: Addr_43, Priority: 0.043000000000000003
 Time: 44.0 | Customer ID: ID_0044, Name: Customer_0044, Addr: Addr_44, Priority: 0.044000000000000004
 Time: 45.0 | Customer ID: ID_0045, Name: Customer_0045, Addr: Addr_45, Priority: 0.18
 Time: 46.0 | Customer ID: ID_0046, Name: Customer_0046, Addr: Addr_46, Priority: 0.046
 Time: 47.0 | Customer ID: ID_0047, Name: Customer_0047, Addr: Addr_47, Priority: 0.188
 Time: 48.0 | Customer ID: ID_0048, Name: Customer_0048, Addr: Addr_48, Priority: 0.096
 Time: 49.0 | Customer ID: ID_0049, Name: Customer_0049, Addr: Addr_49, Priority: 0.147
 Time: 50.0 | Customer ID: ID_0050, Name: Customer_0050, Addr: Addr_50, Priority: 0.1
 Time: 51.0 | Customer ID: ID_0051, Name: Customer_0051, Addr: Addr_51, Priority: 0.153
 Time: 52.0 | Customer ID: ID_0052, Name: Customer_0052, Addr: Addr_52, Priority: 0.10400000000000001
 Time: 53.0 | Customer ID: ID_0053, Name: Customer_0053, Addr: Addr_53, Priority: 0.212
 Time: 54.0 | Customer ID: ID_0054, Name: Customer_0054, Addr: Addr_54, Priority: 0.162
 Time: 55.0 | Customer ID: ID_0055, Name: Customer_0055, Addr: Addr_55, Priority: 0.05499999999999999
 Time: 56.0 | Customer ID: ID_0056, Name: Customer_0056, Addr: Addr_56, Priority: 0.224
 Time: 57.0 | Customer ID: ID_0057, Name: Customer_0057, Addr: Addr_57, Priority: 0.056999999999999995
 Time: 58.0 | Customer ID: ID_0058, Name: Customer_0058, Addr: Addr_58, Priority: 0.057999999999999996
 Time: 59.0 | Customer ID: ID_0059, Name: Customer_0059, Addr: Addr_59, Priority: 0.059
 Time: 60.0 | Customer ID: ID_0060, Name: Customer_0060, Addr: Addr_60, Priority: 0.3
 Time: 61.0 | Customer ID: ID_0061, Name: Customer_0061, Addr: Addr_61, Priority: 0.24400000000000002
 Time: 62.0 | Customer ID: ID_0062, Name: Customer_0062, Addr: Addr_62, Priority: 0.248
 Time: 63.0 | Customer ID: ID_0063, Name: Customer_0063, Addr: Addr_63, Priority: 0.189
 Time: 64.0 | Customer ID: ID_0064, Name: Customer_0064, Addr: Addr_64, Priority: 0.128
 Time: 65.0 | Customer ID: ID_0065, Name: Customer_0065, Addr: Addr_65, Priority: 0.26
 Time: 66.0 | Customer ID: ID_0066, Name: Customer_0066, Addr: Addr_66, Priority: 0.32999999999999996
 Time: 67.0 | Customer ID: ID_0067, Name: Customer_0067, Addr: Addr_67, Priority: 0.20099999999999998
 Time: 68.0 | Customer ID: ID_0068, Name: Customer_0068, Addr: Addr_68, Priority: 0.20400000000000001
 Time: 69.0 | Customer ID: ID_0069, Name: Customer_0069, Addr: Addr_69, Priority: 0.27599999999999997
 Time: 70.0 | Customer ID: ID_0070, Name: Customer_0070, Addr: Addr_70, Priority: 0.27999999999999997
 Time: 71.0 | Customer ID: ID_0071, Name: Customer_0071, Addr: Addr_71, Priority: 0.284
 Time: 72.0 | Customer ID: ID_0072, Name: Customer_0072, Addr: Addr_72, Priority: 0.144
 Time: 73.0 | Customer ID: ID_0073, Name: Customer_0073, Addr: Addr_73, Priority: 0.073
 Time: 74.0 | Customer ID: ID_0074, Name: Customer_0074, Addr: Addr_74, Priority: 0.148
 Time: 75.0 | Customer ID: ID_0075, Name: Customer_0075, Addr: Addr_75, Priority: 0.075
 Time: 76.0 | Customer ID: ID_0076, Name: Customer_0076, Addr: Addr_76, Priority: 0.38
 Time: 77.0 | Customer ID: ID_0077, Name: Customer_0077, Addr: Addr_77, Priority: 0.308
 Time: 78.0 | Customer ID: ID_0078, Name: Customer_0078, Addr: Addr_78, Priority: 0.156
 Time: 79.0 | Customer ID: ID_0079, Name: Customer_0079, Addr: Addr_79, Priority: 0.395
 Time: 80.0 | Customer ID: ID_0080, Name: Customer_0080, Addr: Addr_80, Priority: 0.4
 Time: 81.0 | Customer ID: ID_0081, Name: Customer_0081, Addr: Addr_81, Priority: 0.405
 Time: 82.0 | Customer ID: ID_0082, Name: Customer_0082, Addr: Addr_82, Priority: 0.328
 Time: 83.0 | Customer ID: ID_0083, Name: Customer_0083, Addr: Addr_83, Priority: 0.16599999999999998
 Time: 84.0 | Customer ID: ID_0084, Name: Customer_0084, Addr: Addr_84, Priority: 0.08399999999999999
 Time: 85.0 | Customer ID: ID_0085, Name: Customer_0085, Addr: Addr_85, Priority: 0.08499999999999999
 Time: 86.0 | Customer ID: ID_0086, Name: Customer_0086, Addr: Addr_86, Priority: 0.258
 Time: 87.0 | Customer ID: ID_0087, Name: Customer_0087, Addr: Addr_87, Priority: 0.261
 Time: 88.0 | Customer ID: ID_0088, Name: Customer_0088, Addr: Addr_88, Priority: 0.35200000000000004
 Time: 89.0 | Customer ID: ID_0089, Name: Customer_0089, Addr: Addr_89, Priority: 0.44499999999999995
 Time: 90.0 | Customer ID: ID_0090, Name: Customer_0090, Addr: Addr_90, Priority: 0.09
 Time: 91.0 | Customer ID: ID_0091, Name: Customer_0091, Addr: Addr_91, Priority: 0.091
 Time: 92.0 | Customer ID: ID_0092, Name: Customer_0092, Addr: Addr_92, Priority: 0.368
 Time: 93.0 | Customer ID: ID_0093, Name: Customer_0093, Addr: Addr_93, Priority: 0.093
 Time: 94.0 | Customer ID: ID_0094, Name: Customer_0094, Addr: Addr_94, Priority: 0.188
 Time: 95.0 | Customer ID: ID_0095, Name: Customer_0095, Addr: Addr_95, Priority: 0.09499999999999999
 Time: 96.0 | Customer ID: ID_0096, Name: Customer_0096, Addr: Addr_96, Priority: 0.48000000000000004
 Time: 97.0 | Customer ID: ID_0097, Name: Customer_0097, Addr: Addr_97, Priority: 0.38799999999999996
 Time: 98.0 | Customer ID: ID_0098, Name: Customer_0098, Addr: Addr_98, Priority: 0.392
 Time: 99.0 | Customer ID: ID_0099, Name: Customer_0099, Addr: Addr_99, Priority: 0.198
 Time: 100.0 | Customer ID: ID_0100, Name: Customer_0100, Addr: Addr_0, Priority: 0.5
------------------------------------------------------------------------------------------------------------------------
Reached end of read zone.
```

Fig 8 – 100 Element Quick Sort Random Data with Time



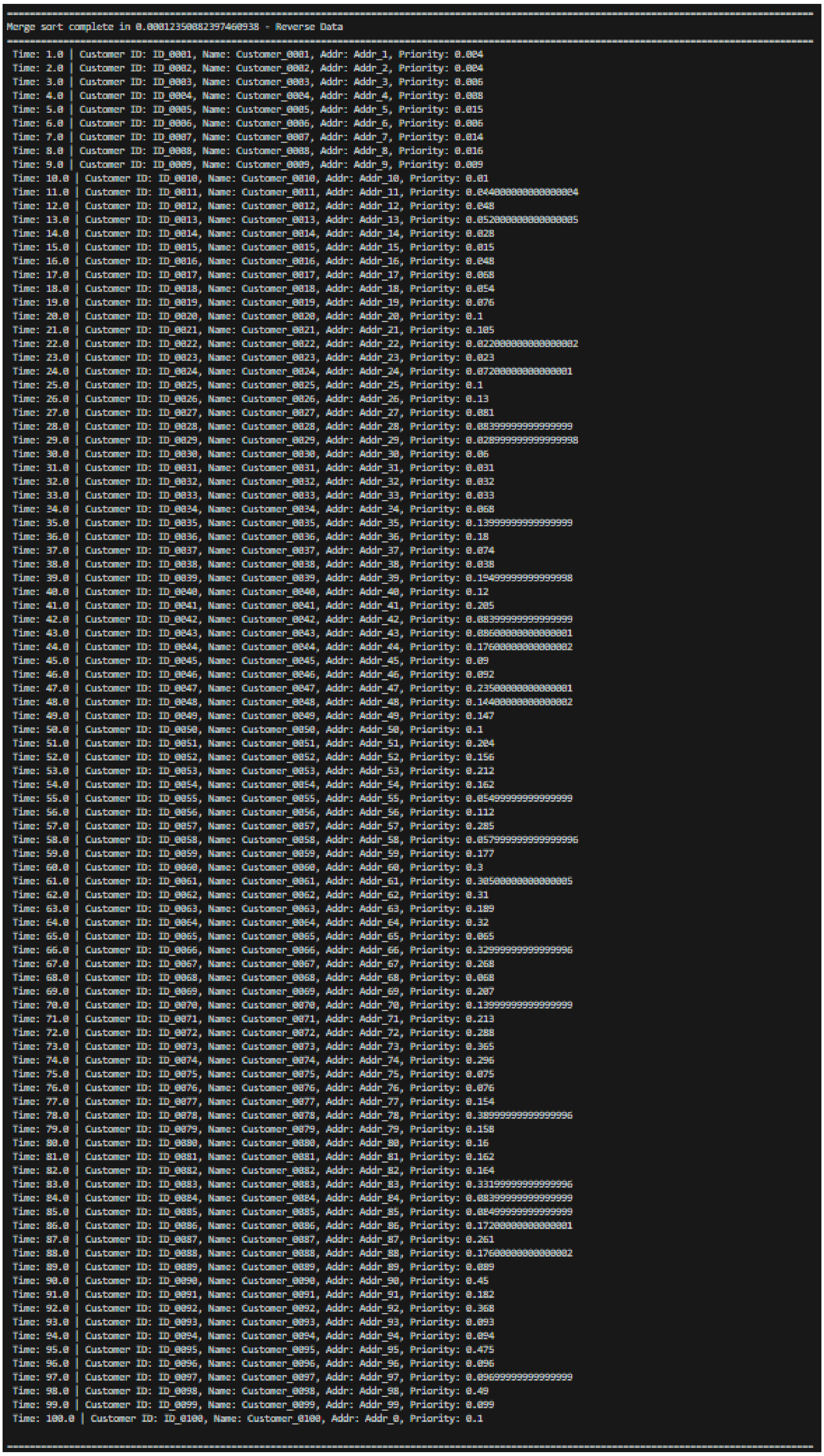
```
================================================================================
Merge sort complete in 0.0001983642578125 - Nearly Sorted Data
================================================================================
 Time: 1.0 | Customer ID: ID_0001, Name: Customer_0001, Addr: Addr_1, Priority: 0.001
 Time: 2.0 | Customer ID: ID_0002, Name: Customer_0002, Addr: Addr_2, Priority: 0.002
 Time: 3.0 | Customer ID: ID_0003, Name: Customer_0003, Addr: Addr_3, Priority: 0.003
 Time: 4.0 | Customer ID: ID_0004, Name: Customer_0004, Addr: Addr_4, Priority: 0.012
 Time: 5.0 | Customer ID: ID_0005, Name: Customer_0005, Addr: Addr_5, Priority: 0.02
 Time: 6.0 | Customer ID: ID_0006, Name: Customer_0006, Addr: Addr_6, Priority: 0.024
 Time: 7.0 | Customer ID: ID_0007, Name: Customer_0007, Addr: Addr_7, Priority: 0.014
 Time: 8.0 | Customer ID: ID_0008, Name: Customer_0008, Addr: Addr_8, Priority: 0.024
 Time: 9.0 | Customer ID: ID_0009, Name: Customer_0009, Addr: Addr_9, Priority: 0.009
 Time: 10.0 | Customer ID: ID_0010, Name: Customer_0010, Addr: Addr_10, Priority: 0.03
 Time: 11.0 | Customer ID: ID_0011, Name: Customer_0011, Addr: Addr_11, Priority: 0.033
 Time: 12.0 | Customer ID: ID_0012, Name: Customer_0012, Addr: Addr_12, Priority: 0.048
 Time: 13.0 | Customer ID: ID_0013, Name: Customer_0013, Addr: Addr_13, Priority: 0.039
 Time: 14.0 | Customer ID: ID_0014, Name: Customer_0014, Addr: Addr_14, Priority: 0.06999999999999999
 Time: 15.0 | Customer ID: ID_0015, Name: Customer_0015, Addr: Addr_15, Priority: 0.03
 Time: 16.0 | Customer ID: ID_0016, Name: Customer_0016, Addr: Addr_16, Priority: 0.064
 Time: 17.0 | Customer ID: ID_0017, Name: Customer_0017, Addr: Addr_17, Priority: 0.034
 Time: 18.0 | Customer ID: ID_0018, Name: Customer_0018, Addr: Addr_18, Priority: 0.054
 Time: 19.0 | Customer ID: ID_0019, Name: Customer_0019, Addr: Addr_19, Priority: 0.038
 Time: 20.0 | Customer ID: ID_0020, Name: Customer_0020, Addr: Addr_20, Priority: 0.08
 Time: 21.0 | Customer ID: ID_0021, Name: Customer_0021, Addr: Addr_21, Priority: 0.08399999999999999
 Time: 22.0 | Customer ID: ID_0022, Name: Customer_0022, Addr: Addr_22, Priority: 0.044000000000000004
 Time: 23.0 | Customer ID: ID_0023, Name: Customer_0023, Addr: Addr_23, Priority: 0.06899999999999999
 Time: 24.0 | Customer ID: ID_0024, Name: Customer_0024, Addr: Addr_24, Priority: 0.07200000000000001
 Time: 25.0 | Customer ID: ID_0025, Name: Customer_0025, Addr: Addr_25, Priority: 0.05
 Time: 26.0 | Customer ID: ID_0026, Name: Customer_0026, Addr: Addr_26, Priority: 0.026000000000000002
 Time: 27.0 | Customer ID: ID_0027, Name: Customer_0027, Addr: Addr_27, Priority: 0.081
 Time: 28.0 | Customer ID: ID_0028, Name: Customer_0028, Addr: Addr_28, Priority: 0.13999999999999999
 Time: 29.0 | Customer ID: ID_0029, Name: Customer_0029, Addr: Addr_29, Priority: 0.057999999999999996
 Time: 30.0 | Customer ID: ID_0030, Name: Customer_0030, Addr: Addr_30, Priority: 0.03
 Time: 31.0 | Customer ID: ID_0031, Name: Customer_0031, Addr: Addr_31, Priority: 0.124
 Time: 32.0 | Customer ID: ID_0032, Name: Customer_0032, Addr: Addr_32, Priority: 0.16
 Time: 33.0 | Customer ID: ID_0033, Name: Customer_0033, Addr: Addr_33, Priority: 0.033
 Time: 34.0 | Customer ID: ID_0034, Name: Customer_0034, Addr: Addr_34, Priority: 0.10200000000000001
 Time: 35.0 | Customer ID: ID_0035, Name: Customer_0035, Addr: Addr_35, Priority: 0.175
 Time: 36.0 | Customer ID: ID_0036, Name: Customer_0036, Addr: Addr_36, Priority: 0.18
 Time: 37.0 | Customer ID: ID_0037, Name: Customer_0037, Addr: Addr_37, Priority: 0.185
 Time: 38.0 | Customer ID: ID_0038, Name: Customer_0038, Addr: Addr_38, Priority: 0.038
 Time: 39.0 | Customer ID: ID_0039, Name: Customer_0039, Addr: Addr_39, Priority: 0.11699999999999999
 Time: 40.0 | Customer ID: ID_0040, Name: Customer_0040, Addr: Addr_40, Priority: 0.08
 Time: 41.0 | Customer ID: ID_0041, Name: Customer_0041, Addr: Addr_41, Priority: 0.164
 Time: 42.0 | Customer ID: ID_0042, Name: Customer_0042, Addr: Addr_42, Priority: 0.21
 Time: 43.0 | Customer ID: ID_0043, Name: Customer_0043, Addr: Addr_43, Priority: 0.21500000000000002
 Time: 44.0 | Customer ID: ID_0044, Name: Customer_0044, Addr: Addr_44, Priority: 0.044000000000000004
 Time: 45.0 | Customer ID: ID_0045, Name: Customer_0045, Addr: Addr_45, Priority: 0.135
 Time: 46.0 | Customer ID: ID_0046, Name: Customer_0046, Addr: Addr_46, Priority: 0.13799999999999998
 Time: 47.0 | Customer ID: ID_0047, Name: Customer_0047, Addr: Addr_47, Priority: 0.14100000000000001
 Time: 48.0 | Customer ID: ID_0048, Name: Customer_0048, Addr: Addr_48, Priority: 0.096
 Time: 49.0 | Customer ID: ID_0049, Name: Customer_0049, Addr: Addr_49, Priority: 0.098
 Time: 50.0 | Customer ID: ID_0050, Name: Customer_0050, Addr: Addr_50, Priority: 0.15
 Time: 51.0 | Customer ID: ID_0051, Name: Customer_0051, Addr: Addr_51, Priority: 0.051
 Time: 52.0 | Customer ID: ID_0052, Name: Customer_0052, Addr: Addr_52, Priority: 0.26
 Time: 53.0 | Customer ID: ID_0053, Name: Customer_0053, Addr: Addr_53, Priority: 0.106
 Time: 54.0 | Customer ID: ID_0054, Name: Customer_0054, Addr: Addr_54, Priority: 0.27
 Time: 55.0 | Customer ID: ID_0055, Name: Customer_0055, Addr: Addr_55, Priority: 0.21999999999999997
 Time: 56.0 | Customer ID: ID_0056, Name: Customer_0056, Addr: Addr_56, Priority: 0.056
 Time: 57.0 | Customer ID: ID_0057, Name: Customer_0057, Addr: Addr_57, Priority: 0.17099999999999999
 Time: 58.0 | Customer ID: ID_0058, Name: Customer_0058, Addr: Addr_58, Priority: 0.174
 Time: 59.0 | Customer ID: ID_0059, Name: Customer_0059, Addr: Addr_59, Priority: 0.177
 Time: 60.0 | Customer ID: ID_0060, Name: Customer_0060, Addr: Addr_60, Priority: 0.18
 Time: 61.0 | Customer ID: ID_0061, Name: Customer_0061, Addr: Addr_61, Priority: 0.24400000000000002
 Time: 62.0 | Customer ID: ID_0062, Name: Customer_0062, Addr: Addr_62, Priority: 0.124
 Time: 63.0 | Customer ID: ID_0063, Name: Customer_0063, Addr: Addr_63, Priority: 0.063
 Time: 64.0 | Customer ID: ID_0064, Name: Customer_0064, Addr: Addr_64, Priority: 0.128
 Time: 65.0 | Customer ID: ID_0065, Name: Customer_0065, Addr: Addr_65, Priority: 0.325
 Time: 66.0 | Customer ID: ID_0066, Name: Customer_0066, Addr: Addr_66, Priority: 0.19799999999999998
 Time: 67.0 | Customer ID: ID_0067, Name: Customer_0067, Addr: Addr_67, Priority: 0.33499999999999996
 Time: 68.0 | Customer ID: ID_0068, Name: Customer_0068, Addr: Addr_68, Priority: 0.34
 Time: 69.0 | Customer ID: ID_0069, Name: Customer_0069, Addr: Addr_69, Priority: 0.27599999999999997
 Time: 70.0 | Customer ID: ID_0070, Name: Customer_0070, Addr: Addr_70, Priority: 0.35
 Time: 71.0 | Customer ID: ID_0071, Name: Customer_0071, Addr: Addr_71, Priority: 0.355
 Time: 72.0 | Customer ID: ID_0072, Name: Customer_0072, Addr: Addr_72, Priority: 0.072
 Time: 73.0 | Customer ID: ID_0073, Name: Customer_0073, Addr: Addr_73, Priority: 0.146
 Time: 74.0 | Customer ID: ID_0074, Name: Customer_0074, Addr: Addr_74, Priority: 0.37
 Time: 75.0 | Customer ID: ID_0075, Name: Customer_0075, Addr: Addr_75, Priority: 0.075
 Time: 76.0 | Customer ID: ID_0076, Name: Customer_0076, Addr: Addr_76, Priority: 0.304
 Time: 77.0 | Customer ID: ID_0077, Name: Customer_0077, Addr: Addr_77, Priority: 0.231
 Time: 78.0 | Customer ID: ID_0078, Name: Customer_0078, Addr: Addr_78, Priority: 0.156
 Time: 79.0 | Customer ID: ID_0079, Name: Customer_0079, Addr: Addr_79, Priority: 0.237
 Time: 80.0 | Customer ID: ID_0080, Name: Customer_0080, Addr: Addr_80, Priority: 0.4
 Time: 81.0 | Customer ID: ID_0081, Name: Customer_0081, Addr: Addr_81, Priority: 0.405
 Time: 82.0 | Customer ID: ID_0082, Name: Customer_0082, Addr: Addr_82, Priority: 0.246
 Time: 83.0 | Customer ID: ID_0083, Name: Customer_0083, Addr: Addr_83, Priority: 0.08299999999999999
 Time: 84.0 | Customer ID: ID_0084, Name: Customer_0084, Addr: Addr_84, Priority: 0.08399999999999999
 Time: 85.0 | Customer ID: ID_0085, Name: Customer_0085, Addr: Addr_85, Priority: 0.16999999999999998
 Time: 86.0 | Customer ID: ID_0086, Name: Customer_0086, Addr: Addr_86, Priority: 0.258
 Time: 87.0 | Customer ID: ID_0087, Name: Customer_0087, Addr: Addr_87, Priority: 0.08700000000000001
 Time: 88.0 | Customer ID: ID_0088, Name: Customer_0088, Addr: Addr_88, Priority: 0.17600000000000002
 Time: 89.0 | Customer ID: ID_0089, Name: Customer_0089, Addr: Addr_89, Priority: 0.356
 Time: 90.0 | Customer ID: ID_0090, Name: Customer_0090, Addr: Addr_90, Priority: 0.27
 Time: 91.0 | Customer ID: ID_0091, Name: Customer_0091, Addr: Addr_91, Priority: 0.182
 Time: 92.0 | Customer ID: ID_0092, Name: Customer_0092, Addr: Addr_92, Priority: 0.092
 Time: 93.0 | Customer ID: ID_0093, Name: Customer_0093, Addr: Addr_93, Priority: 0.279
 Time: 94.0 | Customer ID: ID_0094, Name: Customer_0094, Addr: Addr_94, Priority: 0.188
 Time: 95.0 | Customer ID: ID_0095, Name: Customer_0095, Addr: Addr_95, Priority: 0.475
 Time: 96.0 | Customer ID: ID_0096, Name: Customer_0096, Addr: Addr_96, Priority: 0.48000000000000004
 Time: 97.0 | Customer ID: ID_0097, Name: Customer_0097, Addr: Addr_97, Priority: 0.19399999999999998
 Time: 98.0 | Customer ID: ID_0098, Name: Customer_0098, Addr: Addr_98, Priority: 0.098
 Time: 99.0 | Customer ID: ID_0099, Name: Customer_0099, Addr: Addr_99, Priority: 0.099
 Time: 100.0 | Customer ID: ID_0100, Name: Customer_0100, Addr: Addr_0, Priority: 0.4

================================================================================
```

Fig 9 – 100 Element Merge Sort Nearly Sorted Data with Time



```
Quick sort complete in 0.0002288818359375 - Nearly Sorted Data
==============================================================================================================
 Time: 1.0 | Customer ID: ID_0001, Name: Customer_0001, Addr: Addr_1, Priority: 0.001
 Time: 2.0 | Customer ID: ID_0002, Name: Customer_0002, Addr: Addr_2, Priority: 0.002
 Time: 3.0 | Customer ID: ID_0003, Name: Customer_0003, Addr: Addr_3, Priority: 0.003
 Time: 4.0 | Customer ID: ID_0004, Name: Customer_0004, Addr: Addr_4, Priority: 0.012
 Time: 5.0 | Customer ID: ID_0005, Name: Customer_0005, Addr: Addr_5, Priority: 0.02
 Time: 6.0 | Customer ID: ID_0006, Name: Customer_0006, Addr: Addr_6, Priority: 0.024
 Time: 7.0 | Customer ID: ID_0007, Name: Customer_0007, Addr: Addr_7, Priority: 0.014
 Time: 8.0 | Customer ID: ID_0008, Name: Customer_0008, Addr: Addr_8, Priority: 0.024
 Time: 9.0 | Customer ID: ID_0009, Name: Customer_0009, Addr: Addr_9, Priority: 0.009
 Time: 10.0 | Customer ID: ID_0010, Name: Customer_0010, Addr: Addr_10, Priority: 0.03
 Time: 11.0 | Customer ID: ID_0011, Name: Customer_0011, Addr: Addr_11, Priority: 0.033
 Time: 12.0 | Customer ID: ID_0012, Name: Customer_0012, Addr: Addr_12, Priority: 0.048
 Time: 13.0 | Customer ID: ID_0013, Name: Customer_0013, Addr: Addr_13, Priority: 0.039
 Time: 14.0 | Customer ID: ID_0014, Name: Customer_0014, Addr: Addr_14, Priority: 0.06999999999999999
 Time: 15.0 | Customer ID: ID_0015, Name: Customer_0015, Addr: Addr_15, Priority: 0.03
 Time: 16.0 | Customer ID: ID_0016, Name: Customer_0016, Addr: Addr_16, Priority: 0.064
 Time: 17.0 | Customer ID: ID_0017, Name: Customer_0017, Addr: Addr_17, Priority: 0.034
 Time: 18.0 | Customer ID: ID_0018, Name: Customer_0018, Addr: Addr_18, Priority: 0.054
 Time: 19.0 | Customer ID: ID_0019, Name: Customer_0019, Addr: Addr_19, Priority: 0.038
 Time: 20.0 | Customer ID: ID_0020, Name: Customer_0020, Addr: Addr_20, Priority: 0.08
 Time: 21.0 | Customer ID: ID_0021, Name: Customer_0021, Addr: Addr_21, Priority: 0.08399999999999999
 Time: 22.0 | Customer ID: ID_0022, Name: Customer_0022, Addr: Addr_22, Priority: 0.044000000000000004
 Time: 23.0 | Customer ID: ID_0023, Name: Customer_0023, Addr: Addr_23, Priority: 0.06899999999999999
 Time: 24.0 | Customer ID: ID_0024, Name: Customer_0024, Addr: Addr_24, Priority: 0.07200000000000001
 Time: 25.0 | Customer ID: ID_0025, Name: Customer_0025, Addr: Addr_25, Priority: 0.05
 Time: 26.0 | Customer ID: ID_0026, Name: Customer_0026, Addr: Addr_26, Priority: 0.026000000000000002
 Time: 27.0 | Customer ID: ID_0027, Name: Customer_0027, Addr: Addr_27, Priority: 0.081
 Time: 28.0 | Customer ID: ID_0028, Name: Customer_0028, Addr: Addr_28, Priority: 0.13999999999999999
 Time: 29.0 | Customer ID: ID_0029, Name: Customer_0029, Addr: Addr_29, Priority: 0.057999999999999996
 Time: 30.0 | Customer ID: ID_0030, Name: Customer_0030, Addr: Addr_30, Priority: 0.03
 Time: 31.0 | Customer ID: ID_0031, Name: Customer_0031, Addr: Addr_31, Priority: 0.124
 Time: 32.0 | Customer ID: ID_0032, Name: Customer_0032, Addr: Addr_32, Priority: 0.16
 Time: 33.0 | Customer ID: ID_0033, Name: Customer_0033, Addr: Addr_33, Priority: 0.033
 Time: 34.0 | Customer ID: ID_0034, Name: Customer_0034, Addr: Addr_34, Priority: 0.10200000000000001
 Time: 35.0 | Customer ID: ID_0035, Name: Customer_0035, Addr: Addr_35, Priority: 0.175
 Time: 36.0 | Customer ID: ID_0036, Name: Customer_0036, Addr: Addr_36, Priority: 0.18
 Time: 37.0 | Customer ID: ID_0037, Name: Customer_0037, Addr: Addr_37, Priority: 0.185
 Time: 38.0 | Customer ID: ID_0038, Name: Customer_0038, Addr: Addr_38, Priority: 0.038
 Time: 39.0 | Customer ID: ID_0039, Name: Customer_0039, Addr: Addr_39, Priority: 0.11699999999999999
 Time: 40.0 | Customer ID: ID_0040, Name: Customer_0040, Addr: Addr_40, Priority: 0.08
 Time: 41.0 | Customer ID: ID_0041, Name: Customer_0041, Addr: Addr_41, Priority: 0.164
 Time: 42.0 | Customer ID: ID_0042, Name: Customer_0042, Addr: Addr_42, Priority: 0.21
 Time: 43.0 | Customer ID: ID_0043, Name: Customer_0043, Addr: Addr_43, Priority: 0.21500000000000002
 Time: 44.0 | Customer ID: ID_0044, Name: Customer_0044, Addr: Addr_44, Priority: 0.044000000000000004
 Time: 45.0 | Customer ID: ID_0045, Name: Customer_0045, Addr: Addr_45, Priority: 0.135
 Time: 46.0 | Customer ID: ID_0046, Name: Customer_0046, Addr: Addr_46, Priority: 0.13799999999999998
 Time: 47.0 | Customer ID: ID_0047, Name: Customer_0047, Addr: Addr_47, Priority: 0.14100000000000001
 Time: 48.0 | Customer ID: ID_0048, Name: Customer_0048, Addr: Addr_48, Priority: 0.096
 Time: 49.0 | Customer ID: ID_0049, Name: Customer_0049, Addr: Addr_49, Priority: 0.098
 Time: 50.0 | Customer ID: ID_0050, Name: Customer_0050, Addr: Addr_50, Priority: 0.15
 Time: 51.0 | Customer ID: ID_0051, Name: Customer_0051, Addr: Addr_51, Priority: 0.051
 Time: 52.0 | Customer ID: ID_0052, Name: Customer_0052, Addr: Addr_52, Priority: 0.26
 Time: 53.0 | Customer ID: ID_0053, Name: Customer_0053, Addr: Addr_53, Priority: 0.106
 Time: 54.0 | Customer ID: ID_0054, Name: Customer_0054, Addr: Addr_54, Priority: 0.27
 Time: 55.0 | Customer ID: ID_0055, Name: Customer_0055, Addr: Addr_55, Priority: 0.21999999999999997
 Time: 56.0 | Customer ID: ID_0056, Name: Customer_0056, Addr: Addr_56, Priority: 0.056
 Time: 57.0 | Customer ID: ID_0057, Name: Customer_0057, Addr: Addr_57, Priority: 0.17099999999999999
 Time: 58.0 | Customer ID: ID_0058, Name: Customer_0058, Addr: Addr_58, Priority: 0.174
 Time: 59.0 | Customer ID: ID_0059, Name: Customer_0059, Addr: Addr_59, Priority: 0.177
 Time: 60.0 | Customer ID: ID_0060, Name: Customer_0060, Addr: Addr_60, Priority: 0.18
 Time: 61.0 | Customer ID: ID_0061, Name: Customer_0061, Addr: Addr_61, Priority: 0.24400000000000002
 Time: 62.0 | Customer ID: ID_0062, Name: Customer_0062, Addr: Addr_62, Priority: 0.124
 Time: 63.0 | Customer ID: ID_0063, Name: Customer_0063, Addr: Addr_63, Priority: 0.063
 Time: 64.0 | Customer ID: ID_0064, Name: Customer_0064, Addr: Addr_64, Priority: 0.128
 Time: 65.0 | Customer ID: ID_0065, Name: Customer_0065, Addr: Addr_65, Priority: 0.325
 Time: 66.0 | Customer ID: ID_0066, Name: Customer_0066, Addr: Addr_66, Priority: 0.19799999999999998
 Time: 67.0 | Customer ID: ID_0067, Name: Customer_0067, Addr: Addr_67, Priority: 0.33499999999999996
 Time: 68.0 | Customer ID: ID_0068, Name: Customer_0068, Addr: Addr_68, Priority: 0.34
 Time: 69.0 | Customer ID: ID_0069, Name: Customer_0069, Addr: Addr_69, Priority: 0.27599999999999997
 Time: 70.0 | Customer ID: ID_0070, Name: Customer_0070, Addr: Addr_70, Priority: 0.35
 Time: 71.0 | Customer ID: ID_0071, Name: Customer_0071, Addr: Addr_71, Priority: 0.355
 Time: 72.0 | Customer ID: ID_0072, Name: Customer_0072, Addr: Addr_72, Priority: 0.072
 Time: 73.0 | Customer ID: ID_0073, Name: Customer_0073, Addr: Addr_73, Priority: 0.146
 Time: 74.0 | Customer ID: ID_0074, Name: Customer_0074, Addr: Addr_74, Priority: 0.37
 Time: 75.0 | Customer ID: ID_0075, Name: Customer_0075, Addr: Addr_75, Priority: 0.075
 Time: 76.0 | Customer ID: ID_0076, Name: Customer_0076, Addr: Addr_76, Priority: 0.304
 Time: 77.0 | Customer ID: ID_0077, Name: Customer_0077, Addr: Addr_77, Priority: 0.231
 Time: 78.0 | Customer ID: ID_0078, Name: Customer_0078, Addr: Addr_78, Priority: 0.156
 Time: 79.0 | Customer ID: ID_0079, Name: Customer_0079, Addr: Addr_79, Priority: 0.237
 Time: 80.0 | Customer ID: ID_0080, Name: Customer_0080, Addr: Addr_80, Priority: 0.4
 Time: 81.0 | Customer ID: ID_0081, Name: Customer_0081, Addr: Addr_81, Priority: 0.405
 Time: 82.0 | Customer ID: ID_0082, Name: Customer_0082, Addr: Addr_82, Priority: 0.246
 Time: 83.0 | Customer ID: ID_0083, Name: Customer_0083, Addr: Addr_83, Priority: 0.08299999999999999
 Time: 84.0 | Customer ID: ID_0084, Name: Customer_0084, Addr: Addr_84, Priority: 0.08399999999999999
 Time: 85.0 | Customer ID: ID_0085, Name: Customer_0085, Addr: Addr_85, Priority: 0.16999999999999998
 Time: 86.0 | Customer ID: ID_0086, Name: Customer_0086, Addr: Addr_86, Priority: 0.258
 Time: 87.0 | Customer ID: ID_0087, Name: Customer_0087, Addr: Addr_87, Priority: 0.08700000000000001
 Time: 88.0 | Customer ID: ID_0088, Name: Customer_0088, Addr: Addr_88, Priority: 0.17600000000000002
 Time: 89.0 | Customer ID: ID_0089, Name: Customer_0089, Addr: Addr_89, Priority: 0.356
 Time: 90.0 | Customer ID: ID_0090, Name: Customer_0090, Addr: Addr_90, Priority: 0.27
 Time: 91.0 | Customer ID: ID_0091, Name: Customer_0091, Addr: Addr_91, Priority: 0.182
 Time: 92.0 | Customer ID: ID_0092, Name: Customer_0092, Addr: Addr_92, Priority: 0.092
 Time: 93.0 | Customer ID: ID_0093, Name: Customer_0093, Addr: Addr_93, Priority: 0.279
 Time: 94.0 | Customer ID: ID_0094, Name: Customer_0094, Addr: Addr_94, Priority: 0.188
 Time: 95.0 | Customer ID: ID_0095, Name: Customer_0095, Addr: Addr_95, Priority: 0.475
 Time: 96.0 | Customer ID: ID_0096, Name: Customer_0096, Addr: Addr_96, Priority: 0.48000000000000004
 Time: 97.0 | Customer ID: ID_0097, Name: Customer_0097, Addr: Addr_97, Priority: 0.19399999999999998
 Time: 98.0 | Customer ID: ID_0098, Name: Customer_0098, Addr: Addr_98, Priority: 0.098
 Time: 99.0 | Customer ID: ID_0099, Name: Customer_0099, Addr: Addr_99, Priority: 0.099
 Time: 100.0 | Customer ID: ID_0100, Name: Customer_0100, Addr: Addr_0, Priority: 0.4
==============================================================================================================
Reached end of read zone.
```

Fig 10 – 100 Element Quick Sort Nearly Sorted Data with Time



```
==================================================================================================================
Merge sort complete in 0.00012350882397460938 - Reverse Data
==================================================================================================================
 Time: 1.0 | Customer ID: ID_0001, Name: Customer_0001, Addr: Addr_1, Priority: 0.004
 Time: 2.0 | Customer ID: ID_0002, Name: Customer_0002, Addr: Addr_2, Priority: 0.004
 Time: 3.0 | Customer ID: ID_0003, Name: Customer_0003, Addr: Addr_3, Priority: 0.006
 Time: 4.0 | Customer ID: ID_0004, Name: Customer_0004, Addr: Addr_4, Priority: 0.008
 Time: 5.0 | Customer ID: ID_0005, Name: Customer_0005, Addr: Addr_5, Priority: 0.015
 Time: 6.0 | Customer ID: ID_0006, Name: Customer_0006, Addr: Addr_6, Priority: 0.006
 Time: 7.0 | Customer ID: ID_0007, Name: Customer_0007, Addr: Addr_7, Priority: 0.014
 Time: 8.0 | Customer ID: ID_0008, Name: Customer_0008, Addr: Addr_8, Priority: 0.016
 Time: 9.0 | Customer ID: ID_0009, Name: Customer_0009, Addr: Addr_9, Priority: 0.009
 Time: 10.0 | Customer ID: ID_0010, Name: Customer_0010, Addr: Addr_10, Priority: 0.01
 Time: 11.0 | Customer ID: ID_0011, Name: Customer_0011, Addr: Addr_11, Priority: 0.044000000000000004
 Time: 12.0 | Customer ID: ID_0012, Name: Customer_0012, Addr: Addr_12, Priority: 0.048
 Time: 13.0 | Customer ID: ID_0013, Name: Customer_0013, Addr: Addr_13, Priority: 0.052000000000000005
 Time: 14.0 | Customer ID: ID_0014, Name: Customer_0014, Addr: Addr_14, Priority: 0.028
 Time: 15.0 | Customer ID: ID_0015, Name: Customer_0015, Addr: Addr_15, Priority: 0.015
 Time: 16.0 | Customer ID: ID_0016, Name: Customer_0016, Addr: Addr_16, Priority: 0.048
 Time: 17.0 | Customer ID: ID_0017, Name: Customer_0017, Addr: Addr_17, Priority: 0.068
 Time: 18.0 | Customer ID: ID_0018, Name: Customer_0018, Addr: Addr_18, Priority: 0.054
 Time: 19.0 | Customer ID: ID_0019, Name: Customer_0019, Addr: Addr_19, Priority: 0.076
 Time: 20.0 | Customer ID: ID_0020, Name: Customer_0020, Addr: Addr_20, Priority: 0.1
 Time: 21.0 | Customer ID: ID_0021, Name: Customer_0021, Addr: Addr_21, Priority: 0.105
 Time: 22.0 | Customer ID: ID_0022, Name: Customer_0022, Addr: Addr_22, Priority: 0.022000000000000002
 Time: 23.0 | Customer ID: ID_0023, Name: Customer_0023, Addr: Addr_23, Priority: 0.023
 Time: 24.0 | Customer ID: ID_0024, Name: Customer_0024, Addr: Addr_24, Priority: 0.07200000000000001
 Time: 25.0 | Customer ID: ID_0025, Name: Customer_0025, Addr: Addr_25, Priority: 0.1
 Time: 26.0 | Customer ID: ID_0026, Name: Customer_0026, Addr: Addr_26, Priority: 0.13
 Time: 27.0 | Customer ID: ID_0027, Name: Customer_0027, Addr: Addr_27, Priority: 0.081
 Time: 28.0 | Customer ID: ID_0028, Name: Customer_0028, Addr: Addr_28, Priority: 0.08399999999999999
 Time: 29.0 | Customer ID: ID_0029, Name: Customer_0029, Addr: Addr_29, Priority: 0.028999999999999998
 Time: 30.0 | Customer ID: ID_0030, Name: Customer_0030, Addr: Addr_30, Priority: 0.06
 Time: 31.0 | Customer ID: ID_0031, Name: Customer_0031, Addr: Addr_31, Priority: 0.031
 Time: 32.0 | Customer ID: ID_0032, Name: Customer_0032, Addr: Addr_32, Priority: 0.032
 Time: 33.0 | Customer ID: ID_0033, Name: Customer_0033, Addr: Addr_33, Priority: 0.033
 Time: 34.0 | Customer ID: ID_0034, Name: Customer_0034, Addr: Addr_34, Priority: 0.068
 Time: 35.0 | Customer ID: ID_0035, Name: Customer_0035, Addr: Addr_35, Priority: 0.13999999999999999
 Time: 36.0 | Customer ID: ID_0036, Name: Customer_0036, Addr: Addr_36, Priority: 0.18
 Time: 37.0 | Customer ID: ID_0037, Name: Customer_0037, Addr: Addr_37, Priority: 0.074
 Time: 38.0 | Customer ID: ID_0038, Name: Customer_0038, Addr: Addr_38, Priority: 0.038
 Time: 39.0 | Customer ID: ID_0039, Name: Customer_0039, Addr: Addr_39, Priority: 0.19499999999999998
 Time: 40.0 | Customer ID: ID_0040, Name: Customer_0040, Addr: Addr_40, Priority: 0.12
 Time: 41.0 | Customer ID: ID_0041, Name: Customer_0041, Addr: Addr_41, Priority: 0.205
 Time: 42.0 | Customer ID: ID_0042, Name: Customer_0042, Addr: Addr_42, Priority: 0.08399999999999999
 Time: 43.0 | Customer ID: ID_0043, Name: Customer_0043, Addr: Addr_43, Priority: 0.08600000000000001
 Time: 44.0 | Customer ID: ID_0044, Name: Customer_0044, Addr: Addr_44, Priority: 0.17600000000000002
 Time: 45.0 | Customer ID: ID_0045, Name: Customer_0045, Addr: Addr_45, Priority: 0.09
 Time: 46.0 | Customer ID: ID_0046, Name: Customer_0046, Addr: Addr_46, Priority: 0.092
 Time: 47.0 | Customer ID: ID_0047, Name: Customer_0047, Addr: Addr_47, Priority: 0.23500000000000001
 Time: 48.0 | Customer ID: ID_0048, Name: Customer_0048, Addr: Addr_48, Priority: 0.14400000000000002
 Time: 49.0 | Customer ID: ID_0049, Name: Customer_0049, Addr: Addr_49, Priority: 0.147
 Time: 50.0 | Customer ID: ID_0050, Name: Customer_0050, Addr: Addr_50, Priority: 0.1
 Time: 51.0 | Customer ID: ID_0051, Name: Customer_0051, Addr: Addr_51, Priority: 0.204
 Time: 52.0 | Customer ID: ID_0052, Name: Customer_0052, Addr: Addr_52, Priority: 0.156
 Time: 53.0 | Customer ID: ID_0053, Name: Customer_0053, Addr: Addr_53, Priority: 0.212
 Time: 54.0 | Customer ID: ID_0054, Name: Customer_0054, Addr: Addr_54, Priority: 0.162
 Time: 55.0 | Customer ID: ID_0055, Name: Customer_0055, Addr: Addr_55, Priority: 0.05499999999999999
 Time: 56.0 | Customer ID: ID_0056, Name: Customer_0056, Addr: Addr_56, Priority: 0.112
 Time: 57.0 | Customer ID: ID_0057, Name: Customer_0057, Addr: Addr_57, Priority: 0.285
 Time: 58.0 | Customer ID: ID_0058, Name: Customer_0058, Addr: Addr_58, Priority: 0.057999999999999996
 Time: 59.0 | Customer ID: ID_0059, Name: Customer_0059, Addr: Addr_59, Priority: 0.177
 Time: 60.0 | Customer ID: ID_0060, Name: Customer_0060, Addr: Addr_60, Priority: 0.3
 Time: 61.0 | Customer ID: ID_0061, Name: Customer_0061, Addr: Addr_61, Priority: 0.30500000000000005
 Time: 62.0 | Customer ID: ID_0062, Name: Customer_0062, Addr: Addr_62, Priority: 0.31
 Time: 63.0 | Customer ID: ID_0063, Name: Customer_0063, Addr: Addr_63, Priority: 0.189
 Time: 64.0 | Customer ID: ID_0064, Name: Customer_0064, Addr: Addr_64, Priority: 0.32
 Time: 65.0 | Customer ID: ID_0065, Name: Customer_0065, Addr: Addr_65, Priority: 0.065
 Time: 66.0 | Customer ID: ID_0066, Name: Customer_0066, Addr: Addr_66, Priority: 0.32999999999999996
 Time: 67.0 | Customer ID: ID_0067, Name: Customer_0067, Addr: Addr_67, Priority: 0.268
 Time: 68.0 | Customer ID: ID_0068, Name: Customer_0068, Addr: Addr_68, Priority: 0.068
 Time: 69.0 | Customer ID: ID_0069, Name: Customer_0069, Addr: Addr_69, Priority: 0.207
 Time: 70.0 | Customer ID: ID_0070, Name: Customer_0070, Addr: Addr_70, Priority: 0.13999999999999999
 Time: 71.0 | Customer ID: ID_0071, Name: Customer_0071, Addr: Addr_71, Priority: 0.213
 Time: 72.0 | Customer ID: ID_0072, Name: Customer_0072, Addr: Addr_72, Priority: 0.288
 Time: 73.0 | Customer ID: ID_0073, Name: Customer_0073, Addr: Addr_73, Priority: 0.365
 Time: 74.0 | Customer ID: ID_0074, Name: Customer_0074, Addr: Addr_74, Priority: 0.296
 Time: 75.0 | Customer ID: ID_0075, Name: Customer_0075, Addr: Addr_75, Priority: 0.075
 Time: 76.0 | Customer ID: ID_0076, Name: Customer_0076, Addr: Addr_76, Priority: 0.076
 Time: 77.0 | Customer ID: ID_0077, Name: Customer_0077, Addr: Addr_77, Priority: 0.154
 Time: 78.0 | Customer ID: ID_0078, Name: Customer_0078, Addr: Addr_78, Priority: 0.38999999999999996
 Time: 79.0 | Customer ID: ID_0079, Name: Customer_0079, Addr: Addr_79, Priority: 0.158
 Time: 80.0 | Customer ID: ID_0080, Name: Customer_0080, Addr: Addr_80, Priority: 0.16
 Time: 81.0 | Customer ID: ID_0081, Name: Customer_0081, Addr: Addr_81, Priority: 0.162
 Time: 82.0 | Customer ID: ID_0082, Name: Customer_0082, Addr: Addr_82, Priority: 0.164
 Time: 83.0 | Customer ID: ID_0083, Name: Customer_0083, Addr: Addr_83, Priority: 0.33199999999999996
 Time: 84.0 | Customer ID: ID_0084, Name: Customer_0084, Addr: Addr_84, Priority: 0.08399999999999999
 Time: 85.0 | Customer ID: ID_0085, Name: Customer_0085, Addr: Addr_85, Priority: 0.08499999999999999
 Time: 86.0 | Customer ID: ID_0086, Name: Customer_0086, Addr: Addr_86, Priority: 0.17200000000000001
 Time: 87.0 | Customer ID: ID_0087, Name: Customer_0087, Addr: Addr_87, Priority: 0.261
 Time: 88.0 | Customer ID: ID_0088, Name: Customer_0088, Addr: Addr_88, Priority: 0.17600000000000002
 Time: 89.0 | Customer ID: ID_0089, Name: Customer_0089, Addr: Addr_89, Priority: 0.089
 Time: 90.0 | Customer ID: ID_0090, Name: Customer_0090, Addr: Addr_90, Priority: 0.45
 Time: 91.0 | Customer ID: ID_0091, Name: Customer_0091, Addr: Addr_91, Priority: 0.182
 Time: 92.0 | Customer ID: ID_0092, Name: Customer_0092, Addr: Addr_92, Priority: 0.368
 Time: 93.0 | Customer ID: ID_0093, Name: Customer_0093, Addr: Addr_93, Priority: 0.093
 Time: 94.0 | Customer ID: ID_0094, Name: Customer_0094, Addr: Addr_94, Priority: 0.094
 Time: 95.0 | Customer ID: ID_0095, Name: Customer_0095, Addr: Addr_95, Priority: 0.475
 Time: 96.0 | Customer ID: ID_0096, Name: Customer_0096, Addr: Addr_96, Priority: 0.096
 Time: 97.0 | Customer ID: ID_0097, Name: Customer_0097, Addr: Addr_97, Priority: 0.09699999999999999
 Time: 98.0 | Customer ID: ID_0098, Name: Customer_0098, Addr: Addr_98, Priority: 0.49
 Time: 99.0 | Customer ID: ID_0099, Name: Customer_0099, Addr: Addr_99, Priority: 0.099
 Time: 100.0 | Customer ID: ID_0100, Name: Customer_0100, Addr: Addr_0, Priority: 0.1

==================================================================================================================
```

Fig 11 – 100 Element Merge Sort Reversed Data with Time

```
Quick sort complete in 0.0002224445343017578 - Reverse Data
==========================================================================================================================
 Time: 1.0 | Customer ID: ID_0001, Name: Customer_0001, Addr: Addr_1, Priority: 0.004
 Time: 2.0 | Customer ID: ID_0002, Name: Customer_0002, Addr: Addr_2, Priority: 0.004
 Time: 3.0 | Customer ID: ID_0003, Name: Customer_0003, Addr: Addr_3, Priority: 0.006
 Time: 4.0 | Customer ID: ID_0004, Name: Customer_0004, Addr: Addr_4, Priority: 0.008
 Time: 5.0 | Customer ID: ID_0005, Name: Customer_0005, Addr: Addr_5, Priority: 0.015
 Time: 6.0 | Customer ID: ID_0006, Name: Customer_0006, Addr: Addr_6, Priority: 0.006
 Time: 7.0 | Customer ID: ID_0007, Name: Customer_0007, Addr: Addr_7, Priority: 0.014
 Time: 8.0 | Customer ID: ID_0008, Name: Customer_0008, Addr: Addr_8, Priority: 0.016
 Time: 9.0 | Customer ID: ID_0009, Name: Customer_0009, Addr: Addr_9, Priority: 0.009
 Time: 10.0 | Customer ID: ID_0010, Name: Customer_0010, Addr: Addr_10, Priority: 0.01
 Time: 11.0 | Customer ID: ID_0011, Name: Customer_0011, Addr: Addr_11, Priority: 0.044000000000000004
 Time: 12.0 | Customer ID: ID_0012, Name: Customer_0012, Addr: Addr_12, Priority: 0.048
 Time: 13.0 | Customer ID: ID_0013, Name: Customer_0013, Addr: Addr_13, Priority: 0.052000000000000005
 Time: 14.0 | Customer ID: ID_0014, Name: Customer_0014, Addr: Addr_14, Priority: 0.028
 Time: 15.0 | Customer ID: ID_0015, Name: Customer_0015, Addr: Addr_15, Priority: 0.015
 Time: 16.0 | Customer ID: ID_0016, Name: Customer_0016, Addr: Addr_16, Priority: 0.048
 Time: 17.0 | Customer ID: ID_0017, Name: Customer_0017, Addr: Addr_17, Priority: 0.068
 Time: 18.0 | Customer ID: ID_0018, Name: Customer_0018, Addr: Addr_18, Priority: 0.054
 Time: 19.0 | Customer ID: ID_0019, Name: Customer_0019, Addr: Addr_19, Priority: 0.076
 Time: 20.0 | Customer ID: ID_0020, Name: Customer_0020, Addr: Addr_20, Priority: 0.1
 Time: 21.0 | Customer ID: ID_0021, Name: Customer_0021, Addr: Addr_21, Priority: 0.105
 Time: 22.0 | Customer ID: ID_0022, Name: Customer_0022, Addr: Addr_22, Priority: 0.022000000000000002
 Time: 23.0 | Customer ID: ID_0023, Name: Customer_0023, Addr: Addr_23, Priority: 0.023
 Time: 24.0 | Customer ID: ID_0024, Name: Customer_0024, Addr: Addr_24, Priority: 0.07200000000000001
 Time: 25.0 | Customer ID: ID_0025, Name: Customer_0025, Addr: Addr_25, Priority: 0.1
 Time: 26.0 | Customer ID: ID_0026, Name: Customer_0026, Addr: Addr_26, Priority: 0.13
 Time: 27.0 | Customer ID: ID_0027, Name: Customer_0027, Addr: Addr_27, Priority: 0.081
 Time: 28.0 | Customer ID: ID_0028, Name: Customer_0028, Addr: Addr_28, Priority: 0.08399999999999999
 Time: 29.0 | Customer ID: ID_0029, Name: Customer_0029, Addr: Addr_29, Priority: 0.028999999999999998
 Time: 30.0 | Customer ID: ID_0030, Name: Customer_0030, Addr: Addr_30, Priority: 0.06
 Time: 31.0 | Customer ID: ID_0031, Name: Customer_0031, Addr: Addr_31, Priority: 0.031
 Time: 32.0 | Customer ID: ID_0032, Name: Customer_0032, Addr: Addr_32, Priority: 0.032
 Time: 33.0 | Customer ID: ID_0033, Name: Customer_0033, Addr: Addr_33, Priority: 0.033
 Time: 34.0 | Customer ID: ID_0034, Name: Customer_0034, Addr: Addr_34, Priority: 0.068
 Time: 35.0 | Customer ID: ID_0035, Name: Customer_0035, Addr: Addr_35, Priority: 0.13999999999999999
 Time: 36.0 | Customer ID: ID_0036, Name: Customer_0036, Addr: Addr_36, Priority: 0.18
 Time: 37.0 | Customer ID: ID_0037, Name: Customer_0037, Addr: Addr_37, Priority: 0.074
 Time: 38.0 | Customer ID: ID_0038, Name: Customer_0038, Addr: Addr_38, Priority: 0.038
 Time: 39.0 | Customer ID: ID_0039, Name: Customer_0039, Addr: Addr_39, Priority: 0.19499999999999998
 Time: 40.0 | Customer ID: ID_0040, Name: Customer_0040, Addr: Addr_40, Priority: 0.12
 Time: 41.0 | Customer ID: ID_0041, Name: Customer_0041, Addr: Addr_41, Priority: 0.205
 Time: 42.0 | Customer ID: ID_0042, Name: Customer_0042, Addr: Addr_42, Priority: 0.08399999999999999
 Time: 43.0 | Customer ID: ID_0043, Name: Customer_0043, Addr: Addr_43, Priority: 0.08600000000000001
 Time: 44.0 | Customer ID: ID_0044, Name: Customer_0044, Addr: Addr_44, Priority: 0.17600000000000002
 Time: 45.0 | Customer ID: ID_0045, Name: Customer_0045, Addr: Addr_45, Priority: 0.09
 Time: 46.0 | Customer ID: ID_0046, Name: Customer_0046, Addr: Addr_46, Priority: 0.092
 Time: 47.0 | Customer ID: ID_0047, Name: Customer_0047, Addr: Addr_47, Priority: 0.23500000000000001
 Time: 48.0 | Customer ID: ID_0048, Name: Customer_0048, Addr: Addr_48, Priority: 0.14400000000000002
 Time: 49.0 | Customer ID: ID_0049, Name: Customer_0049, Addr: Addr_49, Priority: 0.147
 Time: 50.0 | Customer ID: ID_0050, Name: Customer_0050, Addr: Addr_50, Priority: 0.1
 Time: 51.0 | Customer ID: ID_0051, Name: Customer_0051, Addr: Addr_51, Priority: 0.204
 Time: 52.0 | Customer ID: ID_0052, Name: Customer_0052, Addr: Addr_52, Priority: 0.156
 Time: 53.0 | Customer ID: ID_0053, Name: Customer_0053, Addr: Addr_53, Priority: 0.212
 Time: 54.0 | Customer ID: ID_0054, Name: Customer_0054, Addr: Addr_54, Priority: 0.162
 Time: 55.0 | Customer ID: ID_0055, Name: Customer_0055, Addr: Addr_55, Priority: 0.05499999999999999
 Time: 56.0 | Customer ID: ID_0056, Name: Customer_0056, Addr: Addr_56, Priority: 0.112
 Time: 57.0 | Customer ID: ID_0057, Name: Customer_0057, Addr: Addr_57, Priority: 0.285
 Time: 58.0 | Customer ID: ID_0058, Name: Customer_0058, Addr: Addr_58, Priority: 0.057999999999999996
 Time: 59.0 | Customer ID: ID_0059, Name: Customer_0059, Addr: Addr_59, Priority: 0.177
 Time: 60.0 | Customer ID: ID_0060, Name: Customer_0060, Addr: Addr_60, Priority: 0.3
 Time: 61.0 | Customer ID: ID_0061, Name: Customer_0061, Addr: Addr_61, Priority: 0.30500000000000005
 Time: 62.0 | Customer ID: ID_0062, Name: Customer_0062, Addr: Addr_62, Priority: 0.31
 Time: 63.0 | Customer ID: ID_0063, Name: Customer_0063, Addr: Addr_63, Priority: 0.189
 Time: 64.0 | Customer ID: ID_0064, Name: Customer_0064, Addr: Addr_64, Priority: 0.32
 Time: 65.0 | Customer ID: ID_0065, Name: Customer_0065, Addr: Addr_65, Priority: 0.065
 Time: 66.0 | Customer ID: ID_0066, Name: Customer_0066, Addr: Addr_66, Priority: 0.32999999999999996
 Time: 67.0 | Customer ID: ID_0067, Name: Customer_0067, Addr: Addr_67, Priority: 0.268
 Time: 68.0 | Customer ID: ID_0068, Name: Customer_0068, Addr: Addr_68, Priority: 0.068
 Time: 69.0 | Customer ID: ID_0069, Name: Customer_0069, Addr: Addr_69, Priority: 0.207
 Time: 70.0 | Customer ID: ID_0070, Name: Customer_0070, Addr: Addr_70, Priority: 0.13999999999999999
 Time: 71.0 | Customer ID: ID_0071, Name: Customer_0071, Addr: Addr_71, Priority: 0.213
 Time: 72.0 | Customer ID: ID_0072, Name: Customer_0072, Addr: Addr_72, Priority: 0.288
 Time: 73.0 | Customer ID: ID_0073, Name: Customer_0073, Addr: Addr_73, Priority: 0.365
 Time: 74.0 | Customer ID: ID_0074, Name: Customer_0074, Addr: Addr_74, Priority: 0.296
 Time: 75.0 | Customer ID: ID_0075, Name: Customer_0075, Addr: Addr_75, Priority: 0.075
 Time: 76.0 | Customer ID: ID_0076, Name: Customer_0076, Addr: Addr_76, Priority: 0.076
 Time: 77.0 | Customer ID: ID_0077, Name: Customer_0077, Addr: Addr_77, Priority: 0.154
 Time: 78.0 | Customer ID: ID_0078, Name: Customer_0078, Addr: Addr_78, Priority: 0.38999999999999996
 Time: 79.0 | Customer ID: ID_0079, Name: Customer_0079, Addr: Addr_79, Priority: 0.158
 Time: 80.0 | Customer ID: ID_0080, Name: Customer_0080, Addr: Addr_80, Priority: 0.16
 Time: 81.0 | Customer ID: ID_0081, Name: Customer_0081, Addr: Addr_81, Priority: 0.162
 Time: 82.0 | Customer ID: ID_0082, Name: Customer_0082, Addr: Addr_82, Priority: 0.164
 Time: 83.0 | Customer ID: ID_0083, Name: Customer_0083, Addr: Addr_83, Priority: 0.33199999999999996
 Time: 84.0 | Customer ID: ID_0084, Name: Customer_0084, Addr: Addr_84, Priority: 0.08399999999999999
 Time: 85.0 | Customer ID: ID_0085, Name: Customer_0085, Addr: Addr_85, Priority: 0.08499999999999999
 Time: 86.0 | Customer ID: ID_0086, Name: Customer_0086, Addr: Addr_86, Priority: 0.17200000000000001
 Time: 87.0 | Customer ID: ID_0087, Name: Customer_0087, Addr: Addr_87, Priority: 0.261
 Time: 88.0 | Customer ID: ID_0088, Name: Customer_0088, Addr: Addr_88, Priority: 0.17600000000000002
 Time: 89.0 | Customer ID: ID_0089, Name: Customer_0089, Addr: Addr_89, Priority: 0.089
 Time: 90.0 | Customer ID: ID_0090, Name: Customer_0090, Addr: Addr_90, Priority: 0.45
 Time: 91.0 | Customer ID: ID_0091, Name: Customer_0091, Addr: Addr_91, Priority: 0.182
 Time: 92.0 | Customer ID: ID_0092, Name: Customer_0092, Addr: Addr_92, Priority: 0.368
 Time: 93.0 | Customer ID: ID_0093, Name: Customer_0093, Addr: Addr_93, Priority: 0.093
 Time: 94.0 | Customer ID: ID_0094, Name: Customer_0094, Addr: Addr_94, Priority: 0.094
 Time: 95.0 | Customer ID: ID_0095, Name: Customer_0095, Addr: Addr_95, Priority: 0.475
 Time: 96.0 | Customer ID: ID_0096, Name: Customer_0096, Addr: Addr_96, Priority: 0.096
 Time: 97.0 | Customer ID: ID_0097, Name: Customer_0097, Addr: Addr_97, Priority: 0.09699999999999999
 Time: 98.0 | Customer ID: ID_0098, Name: Customer_0098, Addr: Addr_98, Priority: 0.49
 Time: 99.0 | Customer ID: ID_0099, Name: Customer_0099, Addr: Addr_99, Priority: 0.099
 Time: 100.0 | Customer ID: ID_0100, Name: Customer_0100, Addr: Addr_0, Priority: 0.1
==========================================================================================================================
```

Fig 12 – 100 Element Quick Sort Reversed Data with Time

Reflection

Over the course of the past few weeks, completing this assignment has personally given me a lot of insight into programming a complex interconnected system of software modules that effectively and efficiently process data using self-made data structures and algorithms. I am quite pleased with the outcome of my assignment, it gave me a much deeper understandings of the inner workings of the data structures and algorithms, and it really allows me to appreciate the fact that we can simply call all of this in a programming language using a single simple function instead of having to do all of this from scratch.

I am particularly pleased with how feature-rich I have made my program allowing for multiple ways of moving data to and from different modules, in particular I am impressed with how I have been able to use a heap object to keep essential delivery information to sort it in the last module to ensure that I do not have to go and match data to the sorted times. I would have never thought that would ever work before this assignment. I have also managed to learn a lot about how the data structures are loaded into memory and how I can access their relative information. This was particularly the case when I was trying to sort delivery data as I would constantly get errors until I printed the outputs to realise that I was trying to sort heap objects and not the actual times. This also widened my understanding of how computers effectively manage these data structures in memory.

Aside from all of the positives, there are also some areas of improvement. Particularly, with the efficiency of the data structures and algorithms I have implemented. Given that these have been developed from scratch there is obviously room to make them more efficient in terms of space efficiency in memory and how much processing power they need to perform their desired tasks.

To conclude, I have learnt a lot about the data structures and algorithms we have learnt over the course of the semester from hashes and heaps to graphs and the stacks, queues and linked lists that underpin these data structures and algorithms. I have learnt how to effectively implement them all together to make a complex, yet easy to operate software package which is able to effectively demonstrate my learnt knowledge from COMP1002. I have also widened my understanding of potential areas of improvement to my program if I was to attempt it again.

Limitations and Assumptions

Some limitations include:

1. When loading processed data from the heaps back into the hash table, sometimes the system throws an error, but the data still loads into the hash table.

2. With the test cases module, if you do not load CSV file and proceed to run a sort it still outputs a time. I assume that is the time it takes for it to realise the CSV file is not loaded or there is no data to sort.