Core Algorithm Overview

Stated Problem:

The purpose of this program is to determine the best route to deliver packages while keeping the total mileage under 140 miles and delivering all packages on time. Packages constraints range from being delayed to only being able to be loaded on a specific truck, on top of having varying deadlines. The main objective is to use a self-adjusting data structure and develop an algorithm capable of finding an optimal route that adheres to the requirement above. This paper will analyze the chosen algorithm and the space- and time- complexity of major segments and the program as a whole.

B2.Programming Environment:

The program was created in IntelliJ IDEA.

Algorithm Overview:

I have chosen the greedy algorithm because of its ease of use and scalability. It is more than capable of finding the optimal route between packages in a list, at a time. With that being said, it does not find the most optimal route as a whole as it works with what it is given in a specific moment. Although, no matter what specific moment it is, it is capable of finding optimal routes no matter how much it is given allowing the algorithm to work with any size. The efficiency of the result depends on the work done pre-algorithm.

The Greedy Algorithm is executed by:

1. Passing in the list you want to sort and the location we'll start comparing with.
2. Create two loops: one to loop through the list which indicate the start of where we should look for the shortest distance from and the second to loop through the list again, starting from where the first loop's index is located to compare to the package in the first loop.
3. Find distance between package in first loop and package in second loop. The shortest distance will indicate the package that will be delivered next.
4. Every time a minimum distance is found, replace package in first loop with package in second loop and move the first package to recently freed spot in second loop.
5. At the end of second loop, package with minimal distance to previous package will be appended to optimized_list and distance will be appended to distance_list with same index as recently appended package.
6. Repeat for rest of unsorted packages.

The time-complexity of the greedy algorithm has a worst- and best-case runtime of $O(n^2)$. It'll never be better because an empty list will never be passed into the algorithm.

B1. Greedy Algorithm Pseudocode:

```
Import distance_graph from CSV

GreedyAlgorithm(start, package_list) {

# Create variables. Time complexity of O(1)
    hub = "4001 South 700 East"
    optimized_list = []
    distance_list = []
    current_location = start
    next_delivery = None


# First loop indicates where to start sorting from.
# Second loop loops through unsorted packages for shortest distance from
# previous location.
# Time complexity of O(n^2)
# Space complexity of O(1)
    for i in package_list {
        min_distance = greatest int possible
        for j in package_list[starting from i] {
            package = package_list[j]
            package_address = package.getAddress()
            distance = distance_graph.search(current_location,
package_address)

            if distance < min_distance {
                min_distance = distance
                next_delivery = package
                temp = package_list[i]
                package_list[i] = next_delivery
                package_list[j] = temp
            }
        optimized_list.append(next_delivery)
        current_location = next_delivery.getAddress()
        distance_list.append(min_distance)
        }
    }
    to_hub = distance_graph.search(current_location, hub)
    distance_list.append(to_hub)

    return optimized_list, distance_list
}
```

Since an empty list will never be passed into the algorithm, the total time complexity of the greedy algorithm is $O(1) + O(n^2) = O(n^2)$. Time- and space- complexities of major segments and important sections are broken down below :

B3. Space-Time Complexity

main.py

LINE #	SPACE COMPLEXITY	TIME COMPLEXITY
16	O(1)	O(n^2)
29	O(1)	O(n)

HashTable.py

LINE #	SPACE COMPLEXITY	TIME COMPLEXITY
3	O(1)	O(n)
19	O(1)	O(1)
24	O(1)	O(1)
42	O(1)	O(n)
60	O(1)	O(n)
79	0(1)	O(log*n)

CSV.py

LINE #	SPACE COMPLEXITY	TIME COMPLEXITY
8	O(V+E)	O(n^2)
32	O(n)	O(n)

Package.py

LINE #	SPACE COMPLEXITY	TIME COMPLEXITY
5	O(1)	O(1)
47 - 86	O(1)	O(1)

Distances.py

LINE #	SPACE COMPLEXITY	TIME COMPLEXITY
7	O(n)	O(n^2)
59	O(n)	O(n^2)

Graph.py

LINE #	SPACE COMPLEXITY	TIME COMPLEXITY
2 – 16	O(1)	O(1)
20	O(1)	O(n)
29	O(1)	O(n)

Trucks.py

LINE #	SPACE COMPLEXITY	TIME COMPLEXITY
9	O(1)	O(1)
18	O(1)	O(1)
21	O(1)	O(1)
24	O(1)	O(1)
27	O(n)	O(n)
39	O(1)	O(1)
51	O(n)	O(n)
98	O(1)	O(n^2)
132	O(n)	O(n^2)
154	O(n)	O(n^2)

As a whole, the program runs pretty linearly with one section of the program running a time complexity of O(log*n). Because of the nature of the project nothing else is taken into consideration beyond the local machine.

B4.Capabilities

Since I did a hybrid of automation and manual, my solution wouldn't scale as well. I manually chose which truck the urgent packages should go on and I did it in a way where I knew the first list for both trucks wouldn't exceed the maximum capacity. The second list is automated by separating whatever packages are leftover in half and then putting it on the trucks. With that being said, a few changes to the code will give the program the necessary capabilities to scale with however amount of package is being delivered.

The program is capable of sorting out packages that requires to specifically be on truck 2, packages that are going to be delayed, packages that needs to be delivered with a specific package, and packages that has a deadline that isn't EOD. By adding in code to just create a general list for truck one and two for the respective trucks to grab packages from, as oppose to handpicking and placing them in specific lists, the program would be able to scale with any amount of packages. Since the placement of packages are done separately, the algorithm can determine a route with a list of any size.

B5.Efficiency

The program is efficient on average with a time complexity of O(n^2). So, while I wouldn't say it's the fastest and most optimal way of figuring out a route, it does get the job done in an adequate amount of time. The maintainability of the program definitely needs some work with the program not being scalable with packages, at least not in the most optimal way.

B6.Data Structures

I used two different self-adjusting data structures in this program. The first one being a hashtable for the packages and the second one being a graph for the cities and their distances.

The hashtable is easy and flexible to work with since you're using a key to insert and find an element. So not only does this make working with elements easier, but it also results in a faster search time than another data structure like a list. Since you're also using a unique key, it makes working with objects that have unique identifiers easy. Although, it is also a weakness in its own way. Finding elements requires a key, but situations where I might want to sort the elements or find an element with a specific attribute wouldn't be possible because of the way hashtables are structured. I had to place all the elements in a separate list, which resulted in me working more with the list than the hashtable.

The graph allowed for both directed and undirected edges or routes. It also allowed me to use a tuple of two cities as key and their distance from each other as value or weight. This was very efficient in my greedy algorithm since I was able to pass in the addresses of the two packages I was comparing to find their distance. Regretfully, I couldn't find an identifying weakness with the graph because it suited my needs perfectly for the situation.

G1.

8:50

```
Please enter hour (Ex: 10 or 18): 8
Please enter minute (Ex: 0 or 59): 50
ID: 1   Address: 195 W Oakland Ave, Salt Lake City, UT 84115    Deadline: 10:30 AM  Weight: 21  DELIVERED at 08:39 AM
ID: 2   Address: 2530 S 500 E, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 44  AT_HUB
ID: 3   Address: 233 Canyon Rd, Salt Lake City, UT 84103    Deadline: 08:00 PM  Weight: 2   AT_HUB
ID: 4   Address: 380 W 2880 S, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 4   AT_HUB
ID: 5   Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 5   AT_HUB
ID: 6   Address: 3060 Lester St, West Valley City, UT 84119 Deadline: 10:30 AM  Weight: 88  Status: Package not received yet
ID: 7   Address: 1330 2100 S, Salt Lake City, UT 84106  Deadline: 08:00 PM  Weight: 8   DELIVERED at 08:30 AM
ID: 8   Address: 300 State St, Salt Lake City, UT 84103 Deadline: 08:00 PM  Weight: 9   ENROUTE
ID: 9   Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 2   AT_HUB
ID: 10  Address: 600 E 900 South, Salt Lake City, UT 84105  Deadline: 08:00 PM  Weight: 1   AT_HUB
ID: 11  Address: 2600 Taylorsville Blvd, Salt Lake City, UT 84118   Deadline: 08:00 PM  Weight: 1   AT_HUB
ID: 12  Address: 3575 W Valley Central Station bus Loop, West Valley City, UT 84119 Deadline: 08:00 PM  Weight: 1   AT_HUB
ID: 13  Address: 2010 W 500 S, Salt Lake City, UT 84104 Deadline: 10:30 AM  Weight: 2   ENROUTE
ID: 14  Address: 4300 S 1300 E, Millcreek, UT 84117 Deadline: 10:30 AM  Weight: 88  DELIVERED at 08:06 AM
ID: 15  Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 09:00 AM  Weight: 4   DELIVERED at 08:13 AM
ID: 16  Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 10:30 AM  Weight: 88  DELIVERED at 08:13 AM
ID: 17  Address: 3148 S 1100 W, Salt Lake City, UT 84119    Deadline: 08:00 PM  Weight: 2   AT_HUB
ID: 18  Address: 1488 4800 S, Salt Lake City, UT 84123  Deadline: 08:00 PM  Weight: 6   AT_HUB
ID: 19  Address: 177 W Price Ave, Salt Lake City, UT 84115  Deadline: 08:00 PM  Weight: 37  ENROUTE
ID: 20  Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 37  DELIVERED at 08:48 AM
ID: 21  Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 3   DELIVERED at 08:48 AM
ID: 22  Address: 6351 South 900 East, Murray, UT 84121  Deadline: 08:00 PM  Weight: 2   AT_HUB
ID: 23  Address: 5100 South 2700 West, Salt Lake City, UT 84118 Deadline: 08:00 PM  Weight: 5   AT_HUB
ID: 24  Address: 5025 State St, Murray, UT 84107    Deadline: 08:00 PM  Weight: 7   AT_HUB
ID: 25  Address: 5383 South 900 East #104, Salt Lake City, UT 84117 Deadline: 10:30 AM  Weight: 7   Status: Package not received yet
ID: 26  Address: 5383 South 900 East #104, Salt Lake City, UT 84117 Deadline: 08:00 PM  Weight: 25  AT_HUB
ID: 27  Address: 1060 Dalton Ave S, Salt Lake City, UT 84104    Deadline: 08:00 PM  Weight: 5   AT_HUB
ID: 28  Address: 2835 Main St, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 7   Status: Package not received yet
ID: 29  Address: 1330 2100 S, Salt Lake City, UT 84106  Deadline: 10:30 AM  Weight: 2   DELIVERED at 08:30 AM
ID: 30  Address: 300 State St, Salt Lake City, UT 84103 Deadline: 10:30 AM  Weight: 1   ENROUTE
```

```
ID: 30  Address: 300 State St, Salt Lake City, UT 84103 Deadline: 10:30 AM  Weight: 1   ENROUTE
ID: 31  Address: 3365 S 900 W, Salt Lake City, UT 84119 Deadline: 10:30 AM  Weight: 1   AT_HUB
ID: 32  Address: 3365 S 900 W, Salt Lake City, UT 84119 Deadline: 08:00 PM  Weight: 1   Status: Package not received yet
ID: 33  Address: 2530 S 500 E, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 1   AT_HUB
ID: 34  Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 10:30 AM  Weight: 2   DELIVERED at 08:13 AM
ID: 35  Address: 1060 Dalton Ave S, Salt Lake City, UT 84104    Deadline: 08:00 PM  Weight: 88  AT_HUB
ID: 36  Address: 2300 Parkway Blvd, West Valley City, UT 84119  Deadline: 08:00 PM  Weight: 88  AT_HUB
ID: 37  Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 10:30 AM  Weight: 2   ENROUTE
ID: 38  Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 9   AT_HUB
ID: 39  Address: 2010 W 500 S, Salt Lake City, UT 84104 Deadline: 08:00 PM  Weight: 9   ENROUTE
ID: 40  Address: 380 W 2880 S, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 45  DELIVERED at 08:43 AM
```

9:15

```
Please enter hour (Ex: 10 or 18): 9
Please enter minute (Ex: 0 or 59): 15
ID: 1   Address: 195 W Oakland Ave, Salt Lake City, UT 84115    Deadline: 10:30 AM  Weight: 21  DELIVERED at 08:39 AM
ID: 2   Address: 2530 S 500 E, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 44  AT_HUB
ID: 3   Address: 233 Canyon Rd, Salt Lake City, UT 84103    Deadline: 08:00 PM  Weight: 2   ENROUTE
ID: 4   Address: 380 W 2880 S, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 4   AT_HUB
ID: 5   Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 5   ENROUTE
ID: 6   Address: 3060 Lester St, West Valley City, UT 84119 Deadline: 10:30 AM  Weight: 88  ENROUTE
ID: 7   Address: 1330 2100 S, Salt Lake City, UT 84106  Deadline: 08:00 PM  Weight: 8   DELIVERED at 08:30 AM
ID: 8   Address: 300 State St, Salt Lake City, UT 84103 Deadline: 08:00 PM  Weight: 9   ENROUTE
ID: 9   Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 2   AT_HUB
ID: 10  Address: 600 E 900 South, Salt Lake City, UT 84105  Deadline: 08:00 PM  Weight: 1   AT_HUB
ID: 11  Address: 2600 Taylorsville Blvd, Salt Lake City, UT 84118   Deadline: 08:00 PM  Weight: 1   AT_HUB
ID: 12  Address: 3575 W Valley Central Station bus Loop, West Valley City, UT 84119 Deadline: 08:00 PM  Weight: 1   AT_HUB
ID: 13  Address: 2010 W 500 S, Salt Lake City, UT 84104 Deadline: 10:30 AM  Weight: 2   ENROUTE
ID: 14  Address: 4300 S 1300 E, Millcreek, UT 84117 Deadline: 10:30 AM  Weight: 88  DELIVERED at 08:06 AM
ID: 15  Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 09:00 AM  Weight: 4   DELIVERED at 08:13 AM
ID: 16  Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 10:30 AM  Weight: 88  DELIVERED at 08:13 AM
ID: 17  Address: 3148 S 1100 W, Salt Lake City, UT 84119    Deadline: 08:00 PM  Weight: 2   AT_HUB
ID: 18  Address: 1488 4800 S, Salt Lake City, UT 84123  Deadline: 08:00 PM  Weight: 6   ENROUTE
ID: 19  Address: 177 W Price Ave, Salt Lake City, UT 84115  Deadline: 08:00 PM  Weight: 37  DELIVERED at 08:50 AM
ID: 20  Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 37  DELIVERED at 08:48 AM
ID: 21  Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 3   DELIVERED at 08:48 AM
ID: 22  Address: 6351 South 900 East, Murray, UT 84121  Deadline: 08:00 PM  Weight: 2   AT_HUB
ID: 23  Address: 5100 South 2700 West, Salt Lake City, UT 84118 Deadline: 08:00 PM  Weight: 5   AT_HUB
ID: 24  Address: 5025 State St, Murray, UT 84107    Deadline: 08:00 PM  Weight: 7   AT_HUB
ID: 25  Address: 5383 South 900 East #104, Salt Lake City, UT 84117 Deadline: 10:30 AM  Weight: 7   DELIVERED at 09:13 AM
ID: 26  Address: 5383 South 900 East #104, Salt Lake City, UT 84117 Deadline: 08:00 PM  Weight: 25  DELIVERED at 09:13 AM
ID: 27  Address: 1060 Dalton Ave S, Salt Lake City, UT 84104    Deadline: 08:00 PM  Weight: 5   AT_HUB
```

```
ID: 27  Address: 1060 Dalton Ave S, Salt Lake City, UT 84104    Deadline: 08:00 PM  Weight: 5   AT_HUB
ID: 28  Address: 2835 Main St, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 7   ENROUTE
ID: 29  Address: 1330 2100 S, Salt Lake City, UT 84106  Deadline: 10:30 AM  Weight: 2   DELIVERED at 08:30 AM
ID: 30  Address: 300 State St, Salt Lake City, UT 84103 Deadline: 10:30 AM  Weight: 1   ENROUTE
ID: 31  Address: 3365 S 900 W, Salt Lake City, UT 84119 Deadline: 10:30 AM  Weight: 1   ENROUTE
ID: 32  Address: 3365 S 900 W, Salt Lake City, UT 84119 Deadline: 08:00 PM  Weight: 1   ENROUTE
ID: 33  Address: 2530 S 500 E, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 1   AT_HUB
ID: 34  Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 10:30 AM  Weight: 2   DELIVERED at 08:13 AM
ID: 35  Address: 1060 Dalton Ave S, Salt Lake City, UT 84104    Deadline: 08:00 PM  Weight: 88  AT_HUB
ID: 36  Address: 2300 Parkway Blvd, West Valley City, UT 84119  Deadline: 08:00 PM  Weight: 88  ENROUTE
ID: 37  Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 10:30 AM  Weight: 2   DELIVERED at 09:12 AM
ID: 38  Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 9   ENROUTE
ID: 39  Address: 2010 W 500 S, Salt Lake City, UT 84104 Deadline: 08:00 PM  Weight: 9   ENROUTE
ID: 40  Address: 380 W 2880 S, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 45  DELIVERED at 08:43 AM
```

G2.

9:50 AM

```
Please enter hour (Ex: 10 or 18): 9
Please enter minute (Ex: 0 or 59): 50
ID: 1   Address: 195 W Oakland Ave, Salt Lake City, UT 84115    Deadline: 10:30 AM  Weight: 21  DELIVERED at 08:39 AM
ID: 2   Address: 2530 S 500 E, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 44  AT_HUB
ID: 3   Address: 233 Canyon Rd, Salt Lake City, UT 84103    Deadline: 08:00 PM  Weight: 2   ENROUTE
ID: 4   Address: 380 W 2880 S, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 4   AT_HUB
ID: 5   Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 5   ENROUTE
ID: 6   Address: 3060 Lester St, West Valley City, UT 84119 Deadline: 10:30 AM  Weight: 88  DELIVERED at 09:45 AM
ID: 7   Address: 1330 2100 S, Salt Lake City, UT 84106  Deadline: 08:00 PM  Weight: 8   DELIVERED at 08:30 AM
ID: 8   Address: 300 State St, Salt Lake City, UT 84103 Deadline: 08:00 PM  Weight: 9   DELIVERED at 09:15 AM
ID: 9   Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 2   AT_HUB
ID: 10  Address: 600 E 900 South, Salt Lake City, UT 84105  Deadline: 08:00 PM  Weight: 1   AT_HUB
ID: 11  Address: 2600 Taylorsville Blvd, Salt Lake City, UT 84118    Deadline: 08:00 PM  Weight: 1   AT_HUB
ID: 12  Address: 3575 W Valley Central Station bus Loop, West Valley City, UT 84119 Deadline: 08:00 PM  Weight: 1   AT_HUB
ID: 13  Address: 2010 W 500 S, Salt Lake City, UT 84104 Deadline: 10:30 AM  Weight: 2   DELIVERED at 09:29 AM
ID: 14  Address: 4300 S 1300 E, Millcreek, UT 84117 Deadline: 10:30 AM  Weight: 88  DELIVERED at 08:06 AM
ID: 15  Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 09:00 AM  Weight: 4   DELIVERED at 08:13 AM
ID: 16  Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 10:30 AM  Weight: 88  DELIVERED at 08:13 AM
ID: 17  Address: 3148 S 1100 W, Salt Lake City, UT 84119    Deadline: 08:00 PM  Weight: 2   AT_HUB
ID: 18  Address: 1488 4800 S, Salt Lake City, UT 84123  Deadline: 08:00 PM  Weight: 6   ENROUTE
ID: 19  Address: 177 W Price Ave, Salt Lake City, UT 84115  Deadline: 08:00 PM  Weight: 37  DELIVERED at 08:50 AM
ID: 20  Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 37  DELIVERED at 08:48 AM
```

```
ID: 20  Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 37  DELIVERED at 08:48 AM
ID: 21  Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 3   DELIVERED at 08:48 AM
ID: 22  Address: 6351 South 900 East, Murray, UT 84121  Deadline: 08:00 PM  Weight: 2   AT_HUB
ID: 23  Address: 5100 South 2700 West, Salt Lake City, UT 84118 Deadline: 08:00 PM  Weight: 5   AT_HUB
ID: 24  Address: 5025 State St, Murray, UT 84107    Deadline: 08:00 PM  Weight: 7   AT_HUB
ID: 25  Address: 5383 South 900 East #104, Salt Lake City, UT 84117 Deadline: 10:30 AM  Weight: 7   DELIVERED at 09:13 AM
ID: 26  Address: 5383 South 900 East #104, Salt Lake City, UT 84117 Deadline: 08:00 PM  Weight: 25  DELIVERED at 09:13 AM
ID: 27  Address: 1060 Dalton Ave S, Salt Lake City, UT 84104    Deadline: 08:00 PM  Weight: 5   AT_HUB
ID: 28  Address: 2835 Main St, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 7   DELIVERED at 09:30 AM
ID: 29  Address: 1330 2100 S, Salt Lake City, UT 84106  Deadline: 10:30 AM  Weight: 2   DELIVERED at 08:30 AM
ID: 30  Address: 300 State St, Salt Lake City, UT 84103 Deadline: 10:30 AM  Weight: 1   DELIVERED at 09:15 AM
ID: 31  Address: 3365 S 900 W, Salt Lake City, UT 84119 Deadline: 10:30 AM  Weight: 1   DELIVERED at 09:40 AM
ID: 32  Address: 3365 S 900 W, Salt Lake City, UT 84119 Deadline: 08:00 PM  Weight: 1   DELIVERED at 09:40 AM
ID: 33  Address: 2530 S 500 E, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 1   AT_HUB
ID: 34  Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 10:30 AM  Weight: 2   DELIVERED at 08:13 AM
ID: 35  Address: 1060 Dalton Ave S, Salt Lake City, UT 84104    Deadline: 08:00 PM  Weight: 88  AT_HUB
ID: 36  Address: 2300 Parkway Blvd, West Valley City, UT 84119  Deadline: 08:00 PM  Weight: 88  ENROUTE
ID: 37  Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 10:30 AM  Weight: 2   DELIVERED at 09:12 AM
ID: 38  Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 9   ENROUTE
ID: 39  Address: 2010 W 500 S, Salt Lake City, UT 84104 Deadline: 08:00 PM  Weight: 9   DELIVERED at 09:29 AM
ID: 40  Address: 380 W 2880 S, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 45  DELIVERED at 08:43 AM
```

10:10 AM

```
Please enter hour (Ex: 10 or 18): 10
Please enter minute (Ex: 0 or 59): 10
ID: 1    Address: 195 W Oakland Ave, Salt Lake City, UT 84115    Deadline: 10:30 AM  Weight: 21  DELIVERED at 08:39 AM
ID: 2    Address: 2530 S 500 E, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 44  ENROUTE
ID: 3    Address: 233 Canyon Rd, Salt Lake City, UT 84103    Deadline: 08:00 PM  Weight: 2    ENROUTE
ID: 4    Address: 380 W 2880 S, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 4    ENROUTE
ID: 5    Address: 410 S State St, Salt Lake City, UT 84111    Deadline: 08:00 PM  Weight: 5    ENROUTE
ID: 6    Address: 3060 Lester St, West Valley City, UT 84119 Deadline: 10:30 AM  Weight: 88  DELIVERED at 09:45 AM
ID: 7    Address: 1330 2100 S, Salt Lake City, UT 84106  Deadline: 08:00 PM  Weight: 8    DELIVERED at 08:30 AM
ID: 8    Address: 300 State St, Salt Lake City, UT 84103 Deadline: 08:00 PM  Weight: 9    DELIVERED at 09:15 AM
ID: 9    Address: 410 S State St, Salt Lake City, UT 84111    Deadline: 08:00 PM  Weight: 2    AT_HUB
ID: 10   Address: 600 E 900 South, Salt Lake City, UT 84105  Deadline: 08:00 PM  Weight: 1    AT_HUB
ID: 11   Address: 2600 Taylorsville Blvd, Salt Lake City, UT 84118   Deadline: 08:00 PM  Weight: 1    AT_HUB
ID: 12   Address: 3575 W Valley Central Station bus Loop, West Valley City, UT 84119 Deadline: 08:00 PM  Weight: 1    AT_HUB
ID: 13   Address: 2010 W 500 S, Salt Lake City, UT 84104 Deadline: 10:30 AM  Weight: 2    DELIVERED at 09:29 AM
ID: 14   Address: 4300 S 1300 E, Millcreek, UT 84117 Deadline: 10:30 AM  Weight: 88  DELIVERED at 08:06 AM
ID: 15   Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 09:00 AM  Weight: 4    DELIVERED at 08:13 AM
ID: 16   Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 10:30 AM  Weight: 88  DELIVERED at 08:13 AM
ID: 17   Address: 3148 S 1100 W, Salt Lake City, UT 84119    Deadline: 08:00 PM  Weight: 2    ENROUTE
ID: 18   Address: 1488 4800 S, Salt Lake City, UT 84123  Deadline: 08:00 PM  Weight: 6    DELIVERED at 10:03 AM
ID: 19   Address: 177 W Price Ave, Salt Lake City, UT 84115  Deadline: 08:00 PM  Weight: 37  DELIVERED at 08:50 AM
ID: 20   Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 37  DELIVERED at 08:48 AM
```

```
ID: 20   Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 37  DELIVERED at 08:48 AM
ID: 21   Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 3    DELIVERED at 08:48 AM
ID: 22   Address: 6351 South 900 East, Murray, UT 84121  Deadline: 08:00 PM  Weight: 2    ENROUTE
ID: 23   Address: 5100 South 2700 West, Salt Lake City, UT 84118 Deadline: 08:00 PM  Weight: 5    AT_HUB
ID: 24   Address: 5025 State St, Murray, UT 84107     Deadline: 08:00 PM  Weight: 7    ENROUTE
ID: 25   Address: 5383 South 900 East #104, Salt Lake City, UT 84117 Deadline: 10:30 AM  Weight: 7    DELIVERED at 09:13 AM
ID: 26   Address: 5383 South 900 East #104, Salt Lake City, UT 84117 Deadline: 08:00 PM  Weight: 25  DELIVERED at 09:13 AM
ID: 27   Address: 1060 Dalton Ave S, Salt Lake City, UT 84104    Deadline: 08:00 PM  Weight: 5    AT_HUB
ID: 28   Address: 2835 Main St, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 7    DELIVERED at 09:30 AM
ID: 29   Address: 1330 2100 S, Salt Lake City, UT 84106  Deadline: 10:30 AM  Weight: 2    DELIVERED at 08:30 AM
ID: 30   Address: 300 State St, Salt Lake City, UT 84103 Deadline: 10:30 AM  Weight: 1    DELIVERED at 09:15 AM
ID: 31   Address: 3365 S 900 W, Salt Lake City, UT 84119 Deadline: 10:30 AM  Weight: 1    DELIVERED at 09:40 AM
ID: 32   Address: 3365 S 900 W, Salt Lake City, UT 84119 Deadline: 08:00 PM  Weight: 1    DELIVERED at 09:40 AM
ID: 33   Address: 2530 S 500 E, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 1    ENROUTE
ID: 34   Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 10:30 AM  Weight: 2    DELIVERED at 08:13 AM
ID: 35   Address: 1060 Dalton Ave S, Salt Lake City, UT 84104    Deadline: 08:00 PM  Weight: 88  AT_HUB
ID: 36   Address: 2300 Parkway Blvd, West Valley City, UT 84119  Deadline: 08:00 PM  Weight: 88  DELIVERED at 09:50 AM
ID: 37   Address: 410 S State St, Salt Lake City, UT 84111    Deadline: 10:30 AM  Weight: 2    DELIVERED at 09:12 AM
ID: 38   Address: 410 S State St, Salt Lake City, UT 84111    Deadline: 08:00 PM  Weight: 9    ENROUTE
ID: 39   Address: 2010 W 500 S, Salt Lake City, UT 84104 Deadline: 08:00 PM  Weight: 9    DELIVERED at 09:29 AM
ID: 40   Address: 380 W 2880 S, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 45  DELIVERED at 08:43 AM
```

10:20 AM

```
Please enter hour (Ex: 10 or 18): 10
Please enter minute (Ex: 0 or 59): 20
ID: 1   Address: 195 W Oakland Ave, Salt Lake City, UT 84115    Deadline: 10:30 AM  Weight: 21  DELIVERED at 08:39 AM
ID: 2   Address: 2530 S 500 E, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 44  ENROUTE
ID: 3   Address: 233 Canyon Rd, Salt Lake City, UT 84103    Deadline: 08:00 PM  Weight: 2   ENROUTE
ID: 4   Address: 380 W 2880 S, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 4   ENROUTE
ID: 5   Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 5   ENROUTE
ID: 6   Address: 3060 Lester St, West Valley City, UT 84119 Deadline: 10:30 AM  Weight: 88  DELIVERED at 09:45 AM
ID: 7   Address: 1330 2100 S, Salt Lake City, UT 84106  Deadline: 08:00 PM  Weight: 8   DELIVERED at 08:30 AM
ID: 8   Address: 300 State St, Salt Lake City, UT 84103 Deadline: 08:00 PM  Weight: 9   DELIVERED at 09:15 AM
ID: 9   Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 2   AT_HUB
ID: 10  Address: 600 E 900 South, Salt Lake City, UT 84105  Deadline: 08:00 PM  Weight: 1   AT_HUB
ID: 11  Address: 2600 Taylorsville Blvd, Salt Lake City, UT 84118   Deadline: 08:00 PM  Weight: 1   AT_HUB
ID: 12  Address: 3575 W Valley Central Station bus Loop, West Valley City, UT 84119 Deadline: 08:00 PM  Weight: 1   AT_HUB
ID: 13  Address: 2010 W 500 S, Salt Lake City, UT 84104 Deadline: 10:30 AM  Weight: 2   DELIVERED at 09:29 AM
ID: 14  Address: 4300 S 1300 E, Millcreek, UT 84117 Deadline: 10:30 AM  Weight: 88  DELIVERED at 08:06 AM
ID: 15  Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 09:00 AM  Weight: 4   DELIVERED at 08:13 AM
ID: 16  Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 10:30 AM  Weight: 88  DELIVERED at 08:13 AM
ID: 17  Address: 3148 S 1100 W, Salt Lake City, UT 84119    Deadline: 08:00 PM  Weight: 2   ENROUTE
ID: 18  Address: 1488 4800 S, Salt Lake City, UT 84123  Deadline: 08:00 PM  Weight: 6   DELIVERED at 10:03 AM
ID: 19  Address: 177 W Price Ave, Salt Lake City, UT 84115  Deadline: 08:00 PM  Weight: 37  DELIVERED at 08:50 AM
ID: 20  Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 37  DELIVERED at 08:48 AM
```

```
ID: 20  Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 37  DELIVERED at 08:48 AM
ID: 21  Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 3   DELIVERED at 08:48 AM
ID: 22  Address: 6351 South 900 East, Murray, UT 84121  Deadline: 08:00 PM  Weight: 2   ENROUTE
ID: 23  Address: 5100 South 2700 West, Salt Lake City, UT 84118 Deadline: 08:00 PM  Weight: 5   AT_HUB
ID: 24  Address: 5025 State St, Murray, UT 84107    Deadline: 08:00 PM  Weight: 7   DELIVERED at 10:13 AM
ID: 25  Address: 5383 South 900 East #104, Salt Lake City, UT 84117 Deadline: 10:30 AM  Weight: 7   DELIVERED at 09:13 AM
ID: 26  Address: 5383 South 900 East #104, Salt Lake City, UT 84117 Deadline: 08:00 PM  Weight: 25  DELIVERED at 09:13 AM
ID: 27  Address: 1060 Dalton Ave S, Salt Lake City, UT 84104    Deadline: 08:00 PM  Weight: 5   AT_HUB
ID: 28  Address: 2835 Main St, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 7   DELIVERED at 09:30 AM
ID: 29  Address: 1330 2100 S, Salt Lake City, UT 84106  Deadline: 10:30 AM  Weight: 2   DELIVERED at 08:30 AM
ID: 30  Address: 300 State St, Salt Lake City, UT 84103 Deadline: 10:30 AM  Weight: 1   DELIVERED at 09:15 AM
ID: 31  Address: 3365 S 900 W, Salt Lake City, UT 84119 Deadline: 10:30 AM  Weight: 1   DELIVERED at 09:40 AM
ID: 32  Address: 3365 S 900 W, Salt Lake City, UT 84119 Deadline: 08:00 PM  Weight: 1   DELIVERED at 09:40 AM
ID: 33  Address: 2530 S 500 E, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 1   ENROUTE
ID: 34  Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 10:30 AM  Weight: 2   DELIVERED at 08:13 AM
ID: 35  Address: 1060 Dalton Ave S, Salt Lake City, UT 84104    Deadline: 08:00 PM  Weight: 88  AT_HUB
ID: 36  Address: 2300 Parkway Blvd, West Valley City, UT 84119  Deadline: 08:00 PM  Weight: 88  DELIVERED at 09:50 AM
ID: 37  Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 10:30 AM  Weight: 2   DELIVERED at 09:12 AM
ID: 38  Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 9   ENROUTE
ID: 39  Address: 2010 W 500 S, Salt Lake City, UT 84104 Deadline: 08:00 PM  Weight: 9   DELIVERED at 09:29 AM
ID: 40  Address: 380 W 2880 S, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 45  DELIVERED at 08:43 AM
```

G3.

12:00 PM

```
Please enter hour (Ex: 10 or 18): 12
Please enter minute (Ex: 0 or 59): 10
ID: 1   Address: 195 W Oakland Ave, Salt Lake City, UT 84115    Deadline: 10:30 AM  Weight: 21  DELIVERED at 08:39 AM
ID: 2   Address: 2530 S 500 E, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 44  DELIVERED at 10:43 AM
ID: 3   Address: 233 Canyon Rd, Salt Lake City, UT 84103    Deadline: 08:00 PM  Weight: 2   DELIVERED at 10:41 AM
ID: 4   Address: 380 W 2880 S, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 4   DELIVERED at 10:49 AM
ID: 5   Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 5   DELIVERED at 10:38 AM
ID: 6   Address: 3060 Lester St, West Valley City, UT 84119 Deadline: 10:30 AM  Weight: 88  DELIVERED at 09:45 AM
ID: 7   Address: 1330 2100 S, Salt Lake City, UT 84106  Deadline: 08:00 PM  Weight: 8   DELIVERED at 08:30 AM
ID: 8   Address: 300 State St, Salt Lake City, UT 84103 Deadline: 08:00 PM  Weight: 9   DELIVERED at 09:15 AM
ID: 9   Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 2   DELIVERED at 11:29 AM
ID: 10  Address: 600 E 900 South, Salt Lake City, UT 84105  Deadline: 08:00 PM  Weight: 1   DELIVERED at 11:23 AM
ID: 11  Address: 2600 Taylorsville Blvd, Salt Lake City, UT 84118   Deadline: 08:00 PM  Weight: 1   DELIVERED at 12:09 PM
ID: 12  Address: 3575 W Valley Central Station bus Loop, West Valley City, UT 84119 Deadline: 08:00 PM  Weight: 1   ENROUTE
ID: 13  Address: 2010 W 500 S, Salt Lake City, UT 84104 Deadline: 10:30 AM  Weight: 2   DELIVERED at 09:29 AM
ID: 14  Address: 4300 S 1300 E, Millcreek, UT 84117 Deadline: 10:30 AM  Weight: 88  DELIVERED at 08:06 AM
ID: 15  Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 09:00 AM  Weight: 4   DELIVERED at 08:13 AM
ID: 16  Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 10:30 AM  Weight: 88  DELIVERED at 08:13 AM
ID: 17  Address: 3148 S 1100 W, Salt Lake City, UT 84119    Deadline: 08:00 PM  Weight: 2   DELIVERED at 10:56 AM
ID: 18  Address: 1488 4800 S, Salt Lake City, UT 84123  Deadline: 08:00 PM  Weight: 6   DELIVERED at 10:03 AM
ID: 19  Address: 177 W Price Ave, Salt Lake City, UT 84115  Deadline: 08:00 PM  Weight: 37  DELIVERED at 08:50 AM
ID: 20  Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 37  DELIVERED at 08:48 AM
```

```
ID: 20  Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 37  DELIVERED at 08:48 AM
ID: 21  Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 3   DELIVERED at 08:48 AM
ID: 22  Address: 6351 South 900 East, Murray, UT 84121  Deadline: 08:00 PM  Weight: 2   DELIVERED at 10:23 AM
ID: 23  Address: 5100 South 2700 West, Salt Lake City, UT 84118 Deadline: 08:00 PM  Weight: 5   DELIVERED at 12:08 PM
ID: 24  Address: 5025 State St, Murray, UT 84107    Deadline: 08:00 PM  Weight: 7   DELIVERED at 10:13 AM
ID: 25  Address: 5383 South 900 East #104, Salt Lake City, UT 84117 Deadline: 10:30 AM  Weight: 7   DELIVERED at 09:13 AM
ID: 26  Address: 5383 South 900 East #104, Salt Lake City, UT 84117 Deadline: 08:00 PM  Weight: 25  DELIVERED at 09:13 AM
ID: 27  Address: 1060 Dalton Ave S, Salt Lake City, UT 84104    Deadline: 08:00 PM  Weight: 5   DELIVERED at 11:45 AM
ID: 28  Address: 2835 Main St, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 7   DELIVERED at 09:30 AM
ID: 29  Address: 1330 2100 S, Salt Lake City, UT 84106  Deadline: 10:30 AM  Weight: 2   DELIVERED at 08:30 AM
ID: 30  Address: 300 State St, Salt Lake City, UT 84103 Deadline: 10:30 AM  Weight: 1   DELIVERED at 09:15 AM
ID: 31  Address: 3365 S 900 W, Salt Lake City, UT 84119 Deadline: 10:30 AM  Weight: 1   DELIVERED at 09:40 AM
ID: 32  Address: 3365 S 900 W, Salt Lake City, UT 84119 Deadline: 08:00 PM  Weight: 1   DELIVERED at 09:40 AM
ID: 33  Address: 2530 S 500 E, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 1   DELIVERED at 10:43 AM
ID: 34  Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 10:30 AM  Weight: 2   DELIVERED at 08:13 AM
ID: 35  Address: 1060 Dalton Ave S, Salt Lake City, UT 84104    Deadline: 08:00 PM  Weight: 88  DELIVERED at 11:45 AM
ID: 36  Address: 2300 Parkway Blvd, West Valley City, UT 84119  Deadline: 08:00 PM  Weight: 88  DELIVERED at 09:50 AM
ID: 37  Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 10:30 AM  Weight: 2   DELIVERED at 09:12 AM
ID: 38  Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 9   DELIVERED at 10:38 AM
ID: 39  Address: 2010 W 500 S, Salt Lake City, UT 84104 Deadline: 08:00 PM  Weight: 9   DELIVERED at 09:29 AM
ID: 40  Address: 380 W 2880 S, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 45  DELIVERED at 08:43 AM
```

12:40 PM

```
Please enter hour (Ex: 10 or 18): 12
Please enter minute (Ex: 0 or 59): 40
ID: 1    Address: 195 W Oakland Ave, Salt Lake City, UT 84115    Deadline: 10:30 AM  Weight: 21  DELIVERED at 08:39 AM
ID: 2    Address: 2530 S 500 E, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 44  DELIVERED at 10:43 AM
ID: 3    Address: 233 Canyon Rd, Salt Lake City, UT 84103    Deadline: 08:00 PM  Weight: 2   DELIVERED at 10:41 AM
ID: 4    Address: 380 W 2880 S, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 4   DELIVERED at 10:49 AM
ID: 5    Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 5   DELIVERED at 10:38 AM
ID: 6    Address: 3060 Lester St, West Valley City, UT 84119 Deadline: 10:30 AM  Weight: 88  DELIVERED at 09:45 AM
ID: 7    Address: 1330 2100 S, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 8   DELIVERED at 08:30 AM
ID: 8    Address: 300 State St, Salt Lake City, UT 84103 Deadline: 08:00 PM  Weight: 9   DELIVERED at 09:15 AM
ID: 9    Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 2   DELIVERED at 11:29 AM
ID: 10   Address: 600 E 900 South, Salt Lake City, UT 84105  Deadline: 08:00 PM  Weight: 1   DELIVERED at 11:23 AM
ID: 11   Address: 2600 Taylorsville Blvd, Salt Lake City, UT 84118   Deadline: 08:00 PM  Weight: 1   DELIVERED at 12:09 PM
ID: 12   Address: 3575 W Valley Central Station bus Loop, West Valley City, UT 84119 Deadline: 08:00 PM  Weight: 1   DELIVERED at 12:36 PM
ID: 13   Address: 2010 W 500 S, Salt Lake City, UT 84104 Deadline: 10:30 AM  Weight: 2   DELIVERED at 09:29 AM
ID: 14   Address: 4300 S 1300 E, Millcreek, UT 84117 Deadline: 10:30 AM  Weight: 88  DELIVERED at 08:06 AM
ID: 15   Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 09:00 AM  Weight: 4   DELIVERED at 08:13 AM
ID: 16   Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 10:30 AM  Weight: 88  DELIVERED at 08:13 AM
ID: 17   Address: 3148 S 1100 W, Salt Lake City, UT 84119    Deadline: 08:00 PM  Weight: 2   DELIVERED at 10:56 AM
ID: 18   Address: 1488 4800 S, Salt Lake City, UT 84123 Deadline: 08:00 PM  Weight: 6   DELIVERED at 10:03 AM
ID: 19   Address: 177 W Price Ave, Salt Lake City, UT 84115  Deadline: 08:00 PM  Weight: 37  DELIVERED at 08:50 AM
ID: 20   Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 37  DELIVERED at 08:48 AM
```

```
ID: 20   Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 37  DELIVERED at 08:48 AM
ID: 21   Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 3   DELIVERED at 08:48 AM
ID: 22   Address: 6351 South 900 East, Murray, UT 84121  Deadline: 08:00 PM  Weight: 2   DELIVERED at 10:23 AM
ID: 23   Address: 5100 South 2700 West, Salt Lake City, UT 84118 Deadline: 08:00 PM  Weight: 5   DELIVERED at 12:08 PM
ID: 24   Address: 5025 State St, Murray, UT 84107    Deadline: 08:00 PM  Weight: 7   DELIVERED at 10:13 AM
ID: 25   Address: 5383 South 900 East #104, Salt Lake City, UT 84117 Deadline: 10:30 AM  Weight: 7   DELIVERED at 09:13 AM
ID: 26   Address: 5383 South 900 East #104, Salt Lake City, UT 84117 Deadline: 08:00 PM  Weight: 25  DELIVERED at 09:13 AM
ID: 27   Address: 1060 Dalton Ave S, Salt Lake City, UT 84104    Deadline: 08:00 PM  Weight: 5   DELIVERED at 11:45 AM
ID: 28   Address: 2835 Main St, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 7   DELIVERED at 09:30 AM
ID: 29   Address: 1330 2100 S, Salt Lake City, UT 84106 Deadline: 10:30 AM  Weight: 2   DELIVERED at 08:30 AM
ID: 30   Address: 300 State St, Salt Lake City, UT 84103 Deadline: 10:30 AM  Weight: 1   DELIVERED at 09:15 AM
ID: 31   Address: 3365 S 900 W, Salt Lake City, UT 84119 Deadline: 10:30 AM  Weight: 1   DELIVERED at 09:40 AM
ID: 32   Address: 3365 S 900 W, Salt Lake City, UT 84119 Deadline: 08:00 PM  Weight: 1   DELIVERED at 09:40 AM
ID: 33   Address: 2530 S 500 E, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 1   DELIVERED at 10:43 AM
ID: 34   Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 10:30 AM  Weight: 2   DELIVERED at 08:13 AM
ID: 35   Address: 1060 Dalton Ave S, Salt Lake City, UT 84104    Deadline: 08:00 PM  Weight: 88  DELIVERED at 11:45 AM
ID: 36   Address: 2300 Parkway Blvd, West Valley City, UT 84119  Deadline: 08:00 PM  Weight: 88  DELIVERED at 09:50 AM
ID: 37   Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 10:30 AM  Weight: 2   DELIVERED at 09:12 AM
ID: 38   Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 9   DELIVERED at 10:38 AM
ID: 39   Address: 2010 W 500 S, Salt Lake City, UT 84104 Deadline: 08:00 PM  Weight: 9   DELIVERED at 09:29 AM
ID: 40   Address: 380 W 2880 S, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 45  DELIVERED at 08:43 AM
```

1:00 PM

```
Please enter hour (Ex: 10 or 18): 13
Please enter minute (Ex: 0 or 59): 0
ID: 1    Address: 195 W Oakland Ave, Salt Lake City, UT 84115    Deadline: 10:30 AM  Weight: 21  DELIVERED at 08:39 AM
ID: 2    Address: 2530 S 500 E, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 44  DELIVERED at 10:43 AM
ID: 3    Address: 233 Canyon Rd, Salt Lake City, UT 84103    Deadline: 08:00 PM  Weight: 2   DELIVERED at 10:41 AM
ID: 4    Address: 380 W 2880 S, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 4   DELIVERED at 10:49 AM
ID: 5    Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 5   DELIVERED at 10:38 AM
ID: 6    Address: 3060 Lester St, West Valley City, UT 84119 Deadline: 10:30 AM  Weight: 88  DELIVERED at 09:45 AM
ID: 7    Address: 1330 2100 S, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 8   DELIVERED at 08:30 AM
ID: 8    Address: 300 State St, Salt Lake City, UT 84103 Deadline: 08:00 PM  Weight: 9   DELIVERED at 09:15 AM
ID: 9    Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 2   DELIVERED at 11:29 AM
ID: 10   Address: 600 E 900 South, Salt Lake City, UT 84105  Deadline: 08:00 PM  Weight: 1   DELIVERED at 11:23 AM
ID: 11   Address: 2600 Taylorsville Blvd, Salt Lake City, UT 84118   Deadline: 08:00 PM  Weight: 1   DELIVERED at 12:09 PM
ID: 12   Address: 3575 W Valley Central Station bus Loop, West Valley City, UT 84119 Deadline: 08:00 PM  Weight: 1   DELIVERED at 12:36 PM
ID: 13   Address: 2010 W 500 S, Salt Lake City, UT 84104 Deadline: 10:30 AM  Weight: 2   DELIVERED at 09:29 AM
ID: 14   Address: 4300 S 1300 E, Millcreek, UT 84117 Deadline: 10:30 AM  Weight: 88  DELIVERED at 08:06 AM
ID: 15   Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 09:00 AM  Weight: 4   DELIVERED at 08:13 AM
ID: 16   Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 10:30 AM  Weight: 88  DELIVERED at 08:13 AM
ID: 17   Address: 3148 S 1100 W, Salt Lake City, UT 84119    Deadline: 08:00 PM  Weight: 2   DELIVERED at 10:56 AM
ID: 18   Address: 1488 4800 S, Salt Lake City, UT 84123 Deadline: 08:00 PM  Weight: 6   DELIVERED at 10:03 AM
ID: 19   Address: 177 W Price Ave, Salt Lake City, UT 84115  Deadline: 08:00 PM  Weight: 37  DELIVERED at 08:50 AM
ID: 20   Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 37  DELIVERED at 08:48 AM
```

```
ID: 20  Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 37  DELIVERED at 08:48 AM
ID: 21  Address: 3595 Main St, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 3   DELIVERED at 08:48 AM
ID: 22  Address: 6351 South 900 East, Murray, UT 84121  Deadline: 08:00 PM  Weight: 2   DELIVERED at 10:23 AM
ID: 23  Address: 5100 South 2700 West, Salt Lake City, UT 84118 Deadline: 08:00 PM  Weight: 5   DELIVERED at 12:08 PM
ID: 24  Address: 5025 State St, Murray, UT 84107    Deadline: 08:00 PM  Weight: 7   DELIVERED at 10:13 AM
ID: 25  Address: 5383 South 900 East #104, Salt Lake City, UT 84117 Deadline: 10:30 AM  Weight: 7   DELIVERED at 09:13 AM
ID: 26  Address: 5383 South 900 East #104, Salt Lake City, UT 84117 Deadline: 08:00 PM  Weight: 25  DELIVERED at 09:13 AM
ID: 27  Address: 1060 Dalton Ave S, Salt Lake City, UT 84104    Deadline: 08:00 PM  Weight: 5   DELIVERED at 11:45 AM
ID: 28  Address: 2835 Main St, Salt Lake City, UT 84115 Deadline: 08:00 PM  Weight: 7   DELIVERED at 09:30 AM
ID: 29  Address: 1330 2100 S, Salt Lake City, UT 84106  Deadline: 10:30 AM  Weight: 2   DELIVERED at 08:30 AM
ID: 30  Address: 300 State St, Salt Lake City, UT 84103 Deadline: 10:30 AM  Weight: 1   DELIVERED at 09:15 AM
ID: 31  Address: 3365 S 900 W, Salt Lake City, UT 84119 Deadline: 10:30 AM  Weight: 1   DELIVERED at 09:40 AM
ID: 32  Address: 3365 S 900 W, Salt Lake City, UT 84119 Deadline: 08:00 PM  Weight: 1   DELIVERED at 09:40 AM
ID: 33  Address: 2530 S 500 E, Salt Lake City, UT 84106 Deadline: 08:00 PM  Weight: 1   DELIVERED at 10:43 AM
ID: 34  Address: 4580 S 2300 E, Holladay, UT 84117  Deadline: 10:30 AM  Weight: 2   DELIVERED at 08:13 AM
ID: 35  Address: 1060 Dalton Ave S, Salt Lake City, UT 84104    Deadline: 08:00 PM  Weight: 88  DELIVERED at 11:45 AM
ID: 36  Address: 2300 Parkway Blvd, West Valley City, UT 84119  Deadline: 08:00 PM  Weight: 88  DELIVERED at 09:50 AM
ID: 37  Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 10:30 AM  Weight: 2   DELIVERED at 09:12 AM
ID: 38  Address: 410 S State St, Salt Lake City, UT 84111   Deadline: 08:00 PM  Weight: 9   DELIVERED at 10:38 AM
ID: 39  Address: 2010 W 500 S, Salt Lake City, UT 84104 Deadline: 08:00 PM  Weight: 9   DELIVERED at 09:29 AM
ID: 40  Address: 380 W 2880 S, Salt Lake City, UT 84115 Deadline: 10:30 AM  Weight: 45  DELIVERED at 08:43 AM
```

H.

```
Welcome to Sabre Nakaahiki's PA project


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Please select a choice using the corresponding numbers:
1. Lookup package
2. List all packages
3. Display total mileage
4. Quit Program
Choose: 3


Trucks delivered all packages with a total mileage of 128.80
```

I.

The greedy algorithm allows one to find the shortest route from one package to another in the moment and is relatively easy to implement. It was more than capable of creating routes that fell below the constraint of 140 miles and delivering all packages on time. I also believe that the brute force algorithm and the branch and bound method would've also been able to complete all the requirements within this scenario.

The brute force algorithm probably leads to a more optimal solution compared to the greedy algorithm since it works by finding all possible routes and picking the shortest one (Ma, 2020). Again, the greedy algorithm finds an optimal route a step at a time, so there's no back stepping to change less optimal routes. The difference is apparent and so is the possible result with how the brute force can make an optimal decision as whole.

The branch and bound method work similarly to the brute force by creating sub-solution. It finds possible routes by using nodes (or points) and traveling down that specific node (find closest city to that point, and so on and so forth) (Ma, 2020). If a sub creates a better solution than what is currently on hand, then the previous solution will be ignored. This is repeated until options are exhausted. As I've already mentioned, greedy algorithm finds the best route a step at a time. So, in comparison, the branch and bound method has a better chance at a more optimal solution as whole.

J.

If I had a chance to do this program over again, I would automate the separation of the packages to create a more optimal route for the algorithm. I separated the process of choosing which package goes where from the algorithm, so the algorithm only had to worry about one thing, but I didn't optimize the list of packages pre-algorithm. I sorted the packages by whether they had to specifically go on truck 2, then packages that had to be linked together, then whether or not the deadlines were before EOD. After that, I put similar addresses together before putting them in their respective trucks. Leftover packages

were just split in half and placed on the trucks. In a sense, I manually chose which packages goes where, which prevented scalability, and it probably didn't help in finding an optimal route. So, given the chance to redo this, I would have tried to find a way to automate the whole process and make it so the list for each trucks were as optimal as possible before sending it to the algorithm.

K1.

For my chaining hash table, the lookup function is wholly dependent on the number of elements within a bucket, as oppose to the number of buckets or total amount of elements. A chaining hash table maps a key associated with a value to a bucket, so unless all the elements uses similar keys all the values are guarantee to end up in different buckets, which makes searching through a bucket like searching through a list, but with less elements to loop through. So, searching through a bucket ends up with $O(n)$ time with a best runtime case of $O(1)$ if the element is in the beginning. The space complexity of the chaining hash table also results in $O(n)$. The space of the hash table is dependent not on the value, since they're fixed, but on the key since they go through the hash function. So, the values aren't taken into consideration with the space-complexity.

The changes to the number of trucks or the number of cities wouldn't make the lookup time any different, since I use the packages for my hash tables. Looking up packages are done with the package's ids so the amount of trucks or cities wouldn't do anything for the data structure.

K2.

An array and a binary search tree would perfectly fit into this scenario as well. An array fulfils the self-adjusting requirement as well as keeping the relationship between elements with its ability to sort itself. An array is capable of being sorted by different attributes (ex: by id or by deadlines) and different sorting algorithms, making searches and finding relationships between elements easier (Sedgewick & Wayne). A binary search tree is similar to a heap, with the difference being the values of the left side of the tree being less than the value of the root, and the value of the right side of the tree being greater (Data Structure - Binary Search Tree). For example, the package's id will be used to decide how the data structure will sort the packages. This keeps the relationship between packages while also making lookup time faster.

Citations

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