C950 WGUPS Algorithm Overview

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C950 Data Structures and Algorithms II

Introduction

This document will go over the algorithm and code I wrote to fulfill the task of delivering all given packages within the provided constraints.

A. Algorithm Identification

Text goes here

The algorithm I chose is the Nearest Neighbor algorithm. This algorithm searches through a list of distances from a starting point and chooses the closest one to go to next. It then removes the selected destination from the list and repeats the search from the new location. It does this until all locations in the original list have been visited. I modified this algorithm slightly by multiplying the measured distance from a point to any destination that did not have a deadline attributed to it. I did this to create a rudimentary prioritization of time sensitive deliveries that would not accidentally skip over "low priority" packages at the same address.

B1. Logic Comments

This pseudocode represents the code that determines the closest package in a list using a table with distances between any two addresses, weighted negatively if the package does not have a delivery deadline. By multiplying the distance of packages without deadlines by 5, packages *with* deadlines will appear relatively closer to the algorithm. Weighted distances will still be zero for a second package going to the address the algorithm is comparing from, and very close weighted destinations will similarly tend to outrank distant unweighted destinations, but in general, packages with deadlines are heavily favored. The algorithm has more variables so that it can keep track of both actual and weighted distances.

```
FUNCTION deliver(truck):
    SET initial distance to 1000
    SET start location to Hub
    CREATE next_package variable
    CREATE traveled variable

    WHILE list of packages on truck has items
        FOR each package ID in truck's package list
            SET actual_distance to the distance from start
            SET weighted_distance to comp_distance
            IF package deadline is EOD
                MULTIPLY weighted_distance by 5
            IF weighted_distance is less than distance
                SET distance to weighted distance
```

```
                    SET travel_distance to actual_distance
                    SET next_package to package ID
        THEN
        ADD travel_distance to traveled variable
        SET next_package departure time to truck departure time
        SET next_package delivery time to departure time PLUS minutes in transit
        REMOVE next_package from truck's package list
        UPDATE start location to next_package location
        RESET distance to 1000
    THEN
    SET truck mileage to traveled PLUS distance back to Hub
    SET truck return time to departure time PLUS minutes in transit
```

B2. Development Environment

PyCharm Community Edition 2023.1

Python 3.11.2

Windows 11 Desktop PC

I used PyCharm to develop this application on my PC. I did not download or use any extensions for it.

B3. Space-Time and Big-O

The hash table has a space complexity of O(n) and the functions in it have O(1) time complexity. The deliver(truck) function has a time complexity of $O(n^2)$ because the function has a for loop nested inside of a while loop. The function that prints has a time complexity of O(1) if printing the information of a single package, and O(n) if printing all because print all utilizes a for loop.

The program has an overall time complexity of $O(n^2)$ based on the deliver function.

B4. Scalability and Adaptability

This program would have to be expanded a bit to scale up. I loaded the trucks manually, and while it would be possible to manually load more packages into more trucks, that is not a scalable solution. I would need to write code to truly interpret delivery deadlines, priority levels, special notes, manage drivers vs trucks, and truck reloads before it could be considered scalable. Also, because the trucks were manually loaded, it does not adapt if the package list is changed, the above mentioned functions would provide that adaptability.

B5. Software Efficiency and Maintainability

My software is efficient and easy to maintain because it is minimal, simple, and has comments explaining what the code does. The code is around 250 lines including all whitespace and comments, and is contained across just 4 files. If it has to be changed for some reason, it will be easy to do so.

B6. Self-Adjusting Data Structures

The strengths of the hash table are how quickly it deals with the data in it and how easily it handles collisions. This means it is well suited to being scaled up. The minor downside is that its size needs to be initiated correctly to balance performance versus wasted space. A larger capacity reduces collisions and consequently speeds performance, but unused buckets do waste some space.

C. Original Code

Code in attached files.

C1. Identification Information

See code.

C2. Process and Flow Comments

See code.

D. Data Structure

The self adjusting data structure is the chaining hash table on HashTable.py.

D1. Explanation of Data Structure

The hash table is based on the chaining hash table outlined in the zyBooks material (Lysecky, section 7) provided. It has been initialized to a size of 17 buckets, fewer than the number of packages, to guarantee it is capable of handling collisions. The unique key is the package ID number, which is linked to a bucket based on the key modulo 17. For insert, search, and remove functions, the bucket is selected with key modulo 17, then a for loop checks the bucket for a key match. A list function compiles a list of all the key values in all the buckets.

The hash table allows either an entire package or any desired element of a package to be accessed with the HashTable.search(key) or HashTable.search(key).element commands.

E. Hash Table

HashTable.py

F. Look-Up Function

Main.py nice_output()

G. Interface

Main.py

G1. First Status Check

All packages at a time between 8:35 a.m. and 9:25 a.m

```
Input a time to check package status (hh:mm am/pm) or type 'quit' to exit. 9:12 am
Enter a package ID number or 'all' to see information for those packages. all
At 09:12 AM package #1, weighing 21 kilos, destined for 195 W Oakland Ave, Salt Lake City UT, 84115 by 10:30 AM, was successfully delivered at 08:38 AM
At 09:12 AM package #2, weighing 44 kilos, destined for 2530 S 500 E, Salt Lake City UT, 84106 by EOD, is not yet out for delivery, but is scheduled to be delivered at 10:57 AM
At 09:12 AM package #3, weighing 2 kilos, destined for 233 Canyon Rd, Salt Lake City UT, 84103 by EOD, is out for delivery and is scheduled to arrive at 10:08 AM
At 09:12 AM package #4, weighing 4 kilos, destined for 380 W 2880 S, Salt Lake City UT, 84115 by EOD, is not yet out for delivery, but is scheduled to be delivered at 10:51 AM
At 09:12 AM package #5, weighing 5 kilos, destined for 410 S State St, Salt Lake City UT, 84111 by EOD, is out for delivery and is scheduled to arrive at 10:04 AM
At 09:12 AM package #6, weighing 88 kilos, destined for 3060 Lester St, West Valley City UT, 84119 by 10:30 AM, is out for delivery and is scheduled to arrive at 09:37 AM
At 09:12 AM package #7, weighing 8 kilos, destined for 1330 2100 S, Salt Lake City UT, 84106 by EOD, was successfully delivered at 08:48 AM
At 09:12 AM package #8, weighing 9 kilos, destined for 300 State St, Salt Lake City UT, 84103 by EOD, is out for delivery and is scheduled to arrive at 10:10 AM
At 09:12 AM package #9, weighing 2 kilos, destined for 300 State St, Salt Lake City UT, 84103 by EOD, is not yet out for delivery, but is scheduled to be delivered at 11:14 AM
At 09:12 AM package #10, weighing 1 kilos, destined for 600 E 900 South, Salt Lake City UT, 84105 by EOD, is out for delivery and is scheduled to arrive at 10:19 AM
At 09:12 AM package #11, weighing 1 kilos, destined for 2600 Taylorsville Blvd, Salt Lake City UT, 84118 by EOD, is not yet out for delivery, but is scheduled to be delivered at 12:04 PM
At 09:12 AM package #12, weighing 1 kilos, destined for 3575 W Valley Central Station bus Loop, West Valley City UT, 84119 by EOD, is not yet out for delivery, but is scheduled to be delivered at 11:38 AM
At 09:12 AM package #13, weighing 2 kilos, destined for 2010 W 500 S, Salt Lake City UT, 84104 by 10:30 AM, is out for delivery and is scheduled to arrive at 09:19 AM
At 09:12 AM package #14, weighing 88 kilos, destined for 4300 S 1300 E, Millcreek UT, 84117 by 10:30 AM, was successfully delivered at 08:06 AM
At 09:12 AM package #15, weighing 4 kilos, destined for 4580 S 2300 E, Holladay UT, 84117 by 9:00 AM, was successfully delivered at 08:13 AM
At 09:12 AM package #16, weighing 88 kilos, destined for 4580 S 2300 E, Holladay UT, 84117 by 10:30 AM, was successfully delivered at 08:13 AM
At 09:12 AM package #17, weighing 2 kilos, destined for 3148 S 1100 W, Salt Lake City UT, 84119 by EOD, is out for delivery and is scheduled to arrive at 09:42 AM
At 09:12 AM package #18, weighing 6 kilos, destined for 1488 4800 S, Salt Lake City UT, 84123 by EOD, is out for delivery and is scheduled to arrive at 11:01 AM
At 09:12 AM package #19, weighing 37 kilos, destined for 177 W Price Ave, Salt Lake City UT, 84115 by EOD, is out for delivery and is scheduled to arrive at 09:45 AM
At 09:12 AM package #20, weighing 37 kilos, destined for 3595 Main St, Salt Lake City UT, 84115 by 10:30 AM, was successfully delivered at 08:29 AM
At 09:12 AM package #21, weighing 3 kilos, destined for 3595 Main St, Salt Lake City UT, 84115 by EOD, was successfully delivered at 08:29 AM
At 09:12 AM package #22, weighing 2 kilos, destined for 6351 South 900 East, Murray UT, 84121 by EOD, is out for delivery and is scheduled to arrive at 11:34 AM
At 09:12 AM package #23, weighing 5 kilos, destined for 5100 South 2700 West, Salt Lake City UT, 84118 by EOD, is not yet out for delivery, but is scheduled to be delivered at 12:03 PM
At 09:12 AM package #24, weighing 7 kilos, destined for 5025 State St, Murray UT, 84107 by EOD, is not yet out for delivery, but is scheduled to be delivered at 10:38 AM
At 09:12 AM package #25, weighing 7 kilos, destined for 5383 S 900 East #104, Salt Lake City UT, 84117 by 10:30 AM, is out for delivery and is scheduled to arrive at 09:13 AM
At 09:12 AM package #26, weighing 25 kilos, destined for 5383 S 900 East #104, Salt Lake City UT, 84117 by EOD, is out for delivery and is scheduled to arrive at 09:13 AM
At 09:12 AM package #27, weighing 5 kilos, destined for 1060 Dalton Ave S, Salt Lake City UT, 84104 by EOD, is out for delivery and is scheduled to arrive at 09:25 AM
At 09:12 AM package #28, weighing 7 kilos, destined for 2835 Main St, Salt Lake City UT, 84115 by EOD, is out for delivery and is scheduled to arrive at 10:31 AM
At 09:12 AM package #29, weighing 2 kilos, destined for 1330 2100 S, Salt Lake City UT, 84106 by 10:30 AM, was successfully delivered at 08:48 AM
At 09:12 AM package #30, weighing 1 kilos, destined for 300 State St, Salt Lake City UT, 84103 by 10:30 AM, was successfully delivered at 09:05 AM
At 09:12 AM package #31, weighing 1 kilos, destined for 3365 S 900 W, Salt Lake City UT, 84119 by 10:30 AM, is out for delivery and is scheduled to arrive at 09:32 AM
At 09:12 AM package #32, weighing 1 kilos, destined for 3365 S 900 W, Salt Lake City UT, 84119 by EOD, is out for delivery and is scheduled to arrive at 09:32 AM
At 09:12 AM package #33, weighing 1 kilos, destined for 2530 S 500 E, Salt Lake City UT, 84106 by EOD, is not yet out for delivery, but is scheduled to be delivered at 10:57 AM
At 09:12 AM package #34, weighing 2 kilos, destined for 4580 S 2300 E, Holladay UT, 84117 by 10:30 AM, was successfully delivered at 08:13 AM
At 09:12 AM package #35, weighing 88 kilos, destined for 1060 Dalton Ave S, Salt Lake City UT, 84104 by EOD, is out for delivery and is scheduled to arrive at 09:25 AM
At 09:12 AM package #36, weighing 88 kilos, destined for 2300 Parkway Blvd, West Valley City UT, 84119 by EOD, is out for delivery and is scheduled to arrive at 10:47 AM
At 09:12 AM package #37, weighing 2 kilos, destined for 410 S State St, Salt Lake City UT, 84111 by 10:30 AM, is out for delivery and is scheduled to arrive at 10:04 AM
At 09:12 AM package #38, weighing 9 kilos, destined for 410 S State St, Salt Lake City UT, 84111 by EOD, is out for delivery and is scheduled to arrive at 10:04 AM
At 09:12 AM package #39, weighing 9 kilos, destined for 2010 W 500 S, Salt Lake City UT, 84104 by EOD, is out for delivery and is scheduled to arrive at 09:19 AM
At 09:12 AM package #40, weighing 45 kilos, destined for 380 W 2880 S, Salt Lake City UT, 84115 by 10:30 AM, was successfully delivered at 08:35 AM
```

G2. Second Status Check

All packages at a time between 9:35 a.m. and 10:25 a.m.

```
Input a time to check package status (hh:mm am/pm) or type 'quit' to exit.10:10 am
Enter a package ID number or 'all' to see information for those packages. all
At 10:10 AM package #1, weighing 21 kilos, destined for 195 W Oakland Ave, Salt Lake City UT, 84115 by 10:30 AM, was successfully delivered at 08:38 AM
At 10:10 AM package #2, weighing 44 kilos, destined for 2530 S 500 E, Salt Lake City UT, 84106 by EOD, is not yet out for delivery, but is scheduled to be delivered at 10:57 AM
At 10:10 AM package #3, weighing 2 kilos, destined for 233 Canyon Rd, Salt Lake City UT, 84103 by EOD, was successfully delivered at 10:08 AM
At 10:10 AM package #4, weighing 4 kilos, destined for 380 W 2880 S, Salt Lake City UT, 84115 by EOD, is not yet out for delivery, but is scheduled to be delivered at 10:51 AM
At 10:10 AM package #5, weighing 5 kilos, destined for 410 S State St, Salt Lake City UT, 84111 by EOD, was successfully delivered at 10:04 AM
At 10:10 AM package #6, weighing 88 kilos, destined for 3060 Lester St, West Valley City UT, 84119 by 10:30 AM, was successfully delivered at 09:37 AM
At 10:10 AM package #7, weighing 8 kilos, destined for 1330 2100 S, Salt Lake City UT, 84106 by EOD, was successfully delivered at 08:48 AM
At 10:10 AM package #8, weighing 9 kilos, destined for 300 State St, Salt Lake City UT, 84103 by EOD, is out for delivery and is scheduled to arrive at 10:10 AM
At 10:10 AM package #9, weighing 2 kilos, destined for 300 State St, Salt Lake City UT, 84103 by EOD, is not yet out for delivery, but is scheduled to be delivered at 11:14 AM
At 10:10 AM package #10, weighing 1 kilos, destined for 600 E 900 South, Salt Lake City UT, 84105 by EOD, is out for delivery and is scheduled to arrive at 10:19 AM
At 10:10 AM package #11, weighing 1 kilos, destined for 2600 Taylorsville Blvd, Salt Lake City UT, 84118 by EOD, is not yet out for delivery, but is scheduled to be delivered at 12:04 PM
At 10:10 AM package #12, weighing 1 kilos, destined for 3575 W Valley Central Station bus Loop, West Valley City UT, 84119 by EOD, is not yet out for delivery, but is scheduled to be delivered at 11:38 AM
At 10:10 AM package #13, weighing 2 kilos, destined for 2010 W 500 S, Salt Lake City UT, 84104 by 10:30 AM, was successfully delivered at 09:19 AM
At 10:10 AM package #14, weighing 88 kilos, destined for 4300 S 1300 E, Millcreek UT, 84117 by 10:30 AM, was successfully delivered at 08:06 AM
At 10:10 AM package #15, weighing 4 kilos, destined for 4580 S 2300 E, Holladay UT, 84117 by 9:00 AM, was successfully delivered at 08:13 AM
At 10:10 AM package #16, weighing 88 kilos, destined for 4580 S 2300 E, Holladay UT, 84117 by 10:30 AM, was successfully delivered at 08:13 AM
At 10:10 AM package #17, weighing 2 kilos, destined for 3148 S 1100 W, Salt Lake City UT, 84119 by EOD, was successfully delivered at 09:42 AM
At 10:10 AM package #18, weighing 6 kilos, destined for 1488 4800 S, Salt Lake City UT, 84123 by EOD, is out for delivery and is scheduled to arrive at 11:01 AM
At 10:10 AM package #19, weighing 37 kilos, destined for 177 W Price Ave, Salt Lake City UT, 84115 by EOD, was successfully delivered at 09:45 AM
At 10:10 AM package #20, weighing 37 kilos, destined for 3595 Main St, Salt Lake City UT, 84115 by 10:30 AM, was successfully delivered at 08:29 AM
At 10:10 AM package #21, weighing 3 kilos, destined for 3595 Main St, Salt Lake City UT, 84115 by EOD, was successfully delivered at 08:29 AM
At 10:10 AM package #22, weighing 2 kilos, destined for 6351 South 900 East, Murray UT, 84121 by EOD, is out for delivery and is scheduled to arrive at 11:34 AM
At 10:10 AM package #23, weighing 5 kilos, destined for 5100 South 2700 West, Salt Lake City UT, 84118 by EOD, is not yet out for delivery, but is scheduled to be delivered at 12:03 PM
At 10:10 AM package #24, weighing 7 kilos, destined for 5025 State St, Murray UT, 84107 by EOD, is not yet out for delivery, but is scheduled to be delivered at 10:38 AM
At 10:10 AM package #25, weighing 7 kilos, destined for 5383 S 900 East #104, Salt Lake City UT, 84117 by 10:30 AM, was successfully delivered at 09:13 AM
At 10:10 AM package #26, weighing 25 kilos, destined for 5383 S 900 East #104, Salt Lake City UT, 84117 by EOD, was successfully delivered at 09:13 AM
At 10:10 AM package #27, weighing 5 kilos, destined for 1060 Dalton Ave S, Salt Lake City UT, 84104 by EOD, was successfully delivered at 09:25 AM
At 10:10 AM package #28, weighing 7 kilos, destined for 2835 Main St, Salt Lake City UT, 84115 by EOD, is out for delivery and is scheduled to arrive at 10:31 AM
At 10:10 AM package #29, weighing 2 kilos, destined for 1330 2100 S, Salt Lake City UT, 84106 by 10:30 AM, was successfully delivered at 08:48 AM
At 10:10 AM package #30, weighing 1 kilos, destined for 300 State St, Salt Lake City UT, 84103 by 10:30 AM, was successfully delivered at 09:05 AM
At 10:10 AM package #31, weighing 1 kilos, destined for 3365 S 900 W, Salt Lake City UT, 84119 by 10:30 AM, was successfully delivered at 09:32 AM
At 10:10 AM package #32, weighing 1 kilos, destined for 3365 S 900 W, Salt Lake City UT, 84119 by EOD, was successfully delivered at 09:32 AM
At 10:10 AM package #33, weighing 1 kilos, destined for 2530 S 500 E, Salt Lake City UT, 84106 by EOD, is not yet out for delivery, but is scheduled to be delivered at 10:57 AM
At 10:10 AM package #34, weighing 2 kilos, destined for 4580 S 2300 E, Holladay UT, 84117 by 10:30 AM, was successfully delivered at 08:13 AM
At 10:10 AM package #35, weighing 88 kilos, destined for 1060 Dalton Ave S, Salt Lake City UT, 84104 by EOD, was successfully delivered at 09:25 AM
At 10:10 AM package #36, weighing 88 kilos, destined for 2300 Parkway Blvd, West Valley City UT, 84119 by EOD, is out for delivery and is scheduled to arrive at 10:47 AM
At 10:10 AM package #37, weighing 2 kilos, destined for 410 S State St, Salt Lake City UT, 84111 by 10:30 AM, was successfully delivered at 10:04 AM
At 10:10 AM package #38, weighing 9 kilos, destined for 410 S State St, Salt Lake City UT, 84111 by EOD, was successfully delivered at 10:04 AM
At 10:10 AM package #39, weighing 9 kilos, destined for 2010 W 500 S, Salt Lake City UT, 84104 by EOD, was successfully delivered at 09:19 AM
At 10:10 AM package #40, weighing 45 kilos, destined for 380 W 2880 S, Salt Lake City UT, 84115 by 10:30 AM, was successfully delivered at 08:35 AM
```

G3. Third Status Check

All packages at a time between 12:03 p.m. and 1:12 p.m.

```
Input a time to check package status (hh:mm am/pm) or type 'quit' to exit.12:09 pm
Enter a package ID number or 'all' to see information for those packages. all
At 12:09 PM package #1, weighing 21 kilos, destined for 195 W Oakland Ave, Salt Lake City UT, 84115 by 10:30 AM, was successfully delivered at 08:38 AM
At 12:09 PM package #2, weighing 44 kilos, destined for 2530 S 500 E, Salt Lake City UT, 84106 by EOD, was successfully delivered at 10:57 AM
At 12:09 PM package #3, weighing 2 kilos, destined for 233 Canyon Rd, Salt Lake City UT, 84103 by EOD, was successfully delivered at 10:08 AM
At 12:09 PM package #4, weighing 4 kilos, destined for 380 W 2880 S, Salt Lake City UT, 84115 by EOD, was successfully delivered at 10:51 AM
At 12:09 PM package #5, weighing 5 kilos, destined for 410 S State St, Salt Lake City UT, 84111 by EOD, was successfully delivered at 10:04 AM
At 12:09 PM package #6, weighing 88 kilos, destined for 3060 Lester St, West Valley City UT, 84119 by 10:30 AM, was successfully delivered at 09:37 AM
At 12:09 PM package #7, weighing 8 kilos, destined for 1330 2100 S, Salt Lake City UT, 84106 by EOD, was successfully delivered at 08:48 AM
At 12:09 PM package #8, weighing 9 kilos, destined for 300 State St, Salt Lake City UT, 84103 by EOD, was successfully delivered at 10:10 AM
At 12:09 PM package #9, weighing 2 kilos, destined for 300 State St, Salt Lake City UT, 84103 by EOD, was successfully delivered at 11:14 AM
At 12:09 PM package #10, weighing 1 kilos, destined for 600 E 900 South, Salt Lake City UT, 84105 by EOD, was successfully delivered at 10:19 AM
At 12:09 PM package #11, weighing 1 kilos, destined for 2600 Taylorsville Blvd, Salt Lake City UT, 84118 by EOD, was successfully delivered at 12:04 PM
At 12:09 PM package #12, weighing 1 kilos, destined for 3575 W Valley Central Station bus Loop, West Valley City UT, 84119 by EOD, was successfully delivered at 11:38 AM
At 12:09 PM package #13, weighing 2 kilos, destined for 2010 W 500 S, Salt Lake City UT, 84104 by 10:30 AM, was successfully delivered at 09:19 AM
At 12:09 PM package #14, weighing 88 kilos, destined for 4300 S 1300 E, Millcreek UT, 84117 by 10:30 AM, was successfully delivered at 08:06 AM
At 12:09 PM package #15, weighing 4 kilos, destined for 4580 S 2300 E, Holladay UT, 84117 by 9:00 AM, was successfully delivered at 08:13 AM
At 12:09 PM package #16, weighing 88 kilos, destined for 4580 S 2300 E, Holladay UT, 84117 by 10:30 AM, was successfully delivered at 08:13 AM
At 12:09 PM package #17, weighing 2 kilos, destined for 3148 S 1100 W, Salt Lake City UT, 84119 by EOD, was successfully delivered at 09:42 AM
At 12:09 PM package #18, weighing 6 kilos, destined for 1488 4800 S, Salt Lake City UT, 84123 by EOD, was successfully delivered at 11:01 AM
At 12:09 PM package #19, weighing 37 kilos, destined for 177 W Price Ave, Salt Lake City UT, 84115 by EOD, was successfully delivered at 09:45 AM
At 12:09 PM package #20, weighing 37 kilos, destined for 3595 Main St, Salt Lake City UT, 84115 by 10:30 AM, was successfully delivered at 08:29 AM
At 12:09 PM package #21, weighing 3 kilos, destined for 3595 Main St, Salt Lake City UT, 84115 by EOD, was successfully delivered at 08:29 AM
At 12:09 PM package #22, weighing 2 kilos, destined for 6351 South 900 East, Murray UT, 84121 by EOD, was successfully delivered at 11:34 AM
At 12:09 PM package #23, weighing 5 kilos, destined for 5100 South 2700 West, Salt Lake City UT, 84118 by EOD, was successfully delivered at 12:03 PM
At 12:09 PM package #24, weighing 7 kilos, destined for 5025 State St, Murray UT, 84107 by EOD, was successfully delivered at 10:38 AM
At 12:09 PM package #25, weighing 7 kilos, destined for 5383 S 900 East #104, Salt Lake City UT, 84117 by 10:30 AM, was successfully delivered at 09:13 AM
At 12:09 PM package #26, weighing 25 kilos, destined for 5383 S 900 East #104, Salt Lake City UT, 84117 by EOD, was successfully delivered at 09:13 AM
At 12:09 PM package #27, weighing 5 kilos, destined for 1060 Dalton Ave S, Salt Lake City UT, 84104 by EOD, was successfully delivered at 09:25 AM
At 12:09 PM package #28, weighing 7 kilos, destined for 2835 Main St, Salt Lake City UT, 84115 by EOD, was successfully delivered at 10:31 AM
At 12:09 PM package #29, weighing 2 kilos, destined for 1330 2100 S, Salt Lake City UT, 84106 by 10:30 AM, was successfully delivered at 08:48 AM
At 12:09 PM package #30, weighing 1 kilos, destined for 300 State St, Salt Lake City UT, 84103 by 10:30 AM, was successfully delivered at 09:05 AM
At 12:09 PM package #31, weighing 1 kilos, destined for 3365 S 900 W, Salt Lake City UT, 84119 by 10:30 AM, was successfully delivered at 09:32 AM
At 12:09 PM package #32, weighing 1 kilos, destined for 3365 S 900 W, Salt Lake City UT, 84119 by EOD, was successfully delivered at 09:32 AM
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At 12:09 PM package #35, weighing 88 kilos, destined for 1060 Dalton Ave S, Salt Lake City UT, 84104 by EOD, was successfully delivered at 09:25 AM
At 12:09 PM package #36, weighing 88 kilos, destined for 2300 Parkway Blvd, West Valley City UT, 84119 by EOD, was successfully delivered at 10:47 AM
At 12:09 PM package #37, weighing 2 kilos, destined for 410 S State St, Salt Lake City UT, 84111 by 10:30 AM, was successfully delivered at 10:04 AM
At 12:09 PM package #38, weighing 9 kilos, destined for 410 S State St, Salt Lake City UT, 84111 by EOD, was successfully delivered at 10:04 AM
At 12:09 PM package #39, weighing 9 kilos, destined for 2010 W 500 S, Salt Lake City UT, 84104 by EOD, was successfully delivered at 09:19 AM
At 12:09 PM package #40, weighing 45 kilos, destined for 380 W 2880 S, Salt Lake City UT, 84115 by 10:30 AM, was successfully delivered at 08:35 AM
```

H. Screenshots of Code Execution

```
C:\Users\Aaron\PycharmProjects\C950\venv\Scripts\python.exe C:\Users\Aaron\PycharmProjects\C950\main.py
All packages delivered and trucks returned at  12:25 PM , with a total of  116.9  miles.
Input a time to check package status (hh:mm am/pm) or type 'quit' to exit. eod
Enter a package ID number or 'all' to see information for those packages. 37
At 12:25 PM package #37, weighing 2 kilos, destined for 410 S State St, Salt Lake City UT, 84111 by 10:30 AM, was successfully delivered at 10:04 AM
Input a time to check package status (hh:mm am/pm) or type 'quit' to exit.bad input
That wasn't what I was expecting, try it again.
Input a time to check package status (hh:mm am/pm) or type 'quit' to exit.10:10 am
Enter a package ID number or 'all' to see information for those packages. 77
There doesn't seem to be a package with that ID number.
Input a time to check package status (hh:mm am/pm) or type 'quit' to exit.10:10 am
Enter a package ID number or 'all' to see information for those packages. 7
At 10:10 AM package #7, weighing 8 kilos, destined for 1330 2100 S, Salt Lake City UT, 84106 by EOD, was successfully delivered at 08:48 AM
Input a time to check package status (hh:mm am/pm) or type 'quit' to exit.quit

Process finished with exit code 0
```

Demonstration of:

1. Initial summary and input prompt
2. Status of package 37 at EOD
3. Return to input prompt
4. Handling of bad input
5. Handling of incorrectly queried package (package ID 77)
6. Status of package 7 at 10:10 AM
7. Successful quit

I1. Strengths of Chosen Algorithm

The primary strength of the nearest neighbor algorithm in this project is that it is easy to understand. I was able to conceptualize and write it quickly in a way that is simple to read and understand. If this was an application that was being utilized by others, the simple straightforwardness of it would benefit other users when they examine the code. Another strength is that it can easily handle more packages if the capacity of the trucks is ever increased. This is a positive for scalability.

I2. Verification of Algorithm

The itself algorithm meets the requirements that all packages are delivered before deadlines and total truck mileage is less than 140. In loading the trucks and setting their depart times manually, I was able to account for all special notes, 16 package max capacity per truck, only 2 trucks being driven at a time, and trucks leaving no earlier than 8:00 AM.

I3. Other possible Algorithms

I could have alternatively used either Dijkstra's algorithm or brute force to find the shortest route, though brute force is not a reasonable option.

I3A. Algorithm Differences

Dijkstra's algorithm is different from the nearest neighbor because uses nodes on a graph and it calculates the shortest route through all the nodes from a starting node to an ending node, and the nearest neighbor is a greedy algorithm that only sees two locations at a time. Dijkstra would probably deliver all the packages in fewer miles than I did.

Brute force would guarantee the optimal route by checking every option, but it would be very resource intensive and slow having a time complexity of O(n!). It is technically optimal but not a reasonable option.

J. Different Approach

If I were to do this project again, I would invest the time to create an automatic truck loader that could load the trucks in an efficient way. This would give the program much more scalability.

K1. Verification of Data Structure

The chaining hash table was very well suited to the needs of this program.

K1A. Efficiency

The time needed to look up data in the chaining hash table does not change much as the number of packages increases. I intentionally set the number of buckets small so that I could have and handle collisions for my own edification, but in a more realistic implementation, the number of buckets would be much larger, and searches would average O(1) time.

K1B. Overhead

The space complexity of the chaining hash table is O(n), so space usage scales proportionately to the number of packages.

K1C. Implications

Adding or removing trucks would not have an effect on the hash table space or look up time, but would have a linear impact on the space usage of trucks.

Adding more destinations would also not have an effect on the hash table space or look up time, but would increase the space usage of the distance map exponentially.

K2. Other Data Structures

A linked list or an AVL tree could have been used instead of the hash table.

K2a. Data Structure Differences

A linked list would always perform searches in O(n) time and insertions or deletions in O(1)time, compared to a hash table that does all in an average of O(1) time but in O(n) time at worst. Considering that the function I used most in my program was the search function, the fast insertion and deletion times do not make up for the search time being equivalent to a hash table’s worst case time.

An AVL tree would perform all the operations in O(log n) time, which is worse than the O(1) time hash table functions usually take, but is better than the worst case O(n) time of the hash table. If the hash table has an appropriate number of buckets, it should outperform an AVL tree.

M. Professional Communication

L. Sources - Works Cited

Text goes here

An example:

Lysecky, R., & Vahid, F. (2018, June). *C950: Data Structures and Algorithms II*. zyBooks.

Retrieved March 22, 2021, from

https://learn.zybooks.com/zybook/WGUC950AY20182019/