A-C. Included in code zip file.

D.

```
Give me a package ID to search. If you would like all packages, type All. If you would like to quit, type Quit. All
Give me a time to search for the package(s) in the form hours:minutes AM/PM. 8:40 AM

Outputting Hash Table of Package(s) All at: 8:40 AM
******************
ID (0) / Dest. Address (1) / Required Delivery Time (2) / Dest. City (3)
Dest. Zipcode (4) / Package Weight (5) / Delivery Status (6) / Delivered At (7)
******************
1,195 W Oakland Ave,10:30 AM,Salt Lake City,84115,21,Delivered by truck #2,8:12AM
2,2530 S 500 E,EOD,Salt Lake City,84106,44,At the hub,NA
3,233 Canyon Rd,EOD,Salt Lake City,84103,2,En route in truck #2,NA
4,380 W 2880 S,EOD,Salt Lake City,84115,4,Delivered by truck #2,8:15AM
5,410 S State St,EOD,Salt Lake City,84111,5,En route in truck #2,NA
6,3060 Lester St,10:30 AM,West Valley City,84119,88,At the hub,NA
7,1330 2100 S,EOD,Salt Lake City,84106,8,Delivered by truck #2,8:27AM
8,300 State St,EOD,Salt Lake City,84103,9,En route in truck #2,NA
9,300 State St,EOD,Salt Lake City,84103,2,At the hub,NA
10,600 E 900 South,EOD,Salt Lake City,84105,1,En route in truck #2,NA
11,2600 Taylorsville Blvd,EOD,Salt Lake City,84118,1,En route in truck #2,NA
12,3575 W Valley Central Station bus Loop,EOD,West Valley City,84119,1,En route in truck #2,NA
13,2010 W 500 S,10:30 AM,Salt Lake City,84104,2,En route in truck #1,NA
14,4300 S 1300 E,10:30 AM,Millcreek,84117,88,Delivered by truck #1,8:18AM
15,4580 S 2300 E,9:00 AM,Holladay,84117,4,Delivered by truck #1,8:11AM
16,4580 S 2300 E,10:30 AM,Holladay,84117,88,Delivered by truck #1,8:11AM
17,3148 S 1100 W,EOD,Salt Lake City,84119,2,At the hub,NA
18,1488 4800 S,EOD,Salt Lake City,84123,6,En route in truck #2,NA
19,177 W Price Ave,EOD,Salt Lake City,84115,37,En route in truck #1,NA
20,3595 Main St,10:30 AM,Salt Lake City,84115,37,Delivered by truck #1,8:28AM
21,3595 Main St,EOD,Salt Lake City,84115,3,Delivered by truck #1,8:28AM
22,6351 South 900 East,EOD,Murray,84121,2,At the hub,NA
23,5100 South 2700 West,EOD,Salt Lake City,84118,5,At the hub,NA
24,5025 State St,EOD,Murray,84107,7,At the hub,NA
25,5383 S 900 East #104,10:30 AM,Salt Lake City,84117,7,At the hub,NA
26,5383 S 900 East #104,EOD,Salt Lake City,84117,25,At the hub,NA
27,1060 Dalton Ave S,EOD,Salt Lake City,84104,5,At the hub,NA
28,2835 Main St,EOD,Salt Lake City,84115,7,At the hub,NA
29,1330 2100 S,10:30 AM,Salt Lake City,84106,2,Delivered by truck #2,8:27AM
30,300 State St,10:30 AM,Salt Lake City,84103,1,En route in truck #2,NA
31,3365 S 900 W,10:30 AM,Salt Lake City,84119,1,At the hub,NA
32,3365 S 900 W,EOD,Salt Lake City,84119,1,At the hub,NA
33,2530 S 500 E,EOD,Salt Lake City,84106,1,At the hub,NA
34,4580 S 2300 E,10:30 AM,Holladay,84117,2,Delivered by truck #1,8:11AM
35,1060 Dalton Ave S,EOD,Salt Lake City,84104,88,At the hub,NA
36,2300 Parkway Blvd,EOD,West Valley City,84119,88,En route in truck #2,NA
37,410 S State St,10:30 AM,Salt Lake City,84111,2,En route in truck #2,NA
38,410 S State St,EOD,Salt Lake City,84111,9,En route in truck #2,NA
39,2010 W 500 S,EOD,Salt Lake City,84104,9,En route in truck #1,NA
40,380 W 2880 S,10:30 AM,Salt Lake City,84115,45,Delivered by truck #2,8:15AM

Truck 1 Total Distance: 11.99999999999999
Truck 2 Total Distance: 11.99999999999999
Truck 3 Total Distance: 0

Give me a package ID to search. If you would like all packages, type All. If you would like to quit, type Quit. All
Give me a time to search for the package(s) in the form hours:minutes AM/PM. 9:40 AM
```

```
Give me a package ID to search. If you would like all packages, type All. If you would like to quit, type Quit. All
Give me a time to search for the package(s) in the form hours:minutes AM/PM. 9:40 AM

Outputting Hash Table of Package(s) All at: 9:40 AM
******************
ID (0) / Dest. Address (1) / Required Delivery Time (2) / Dest. City (3)
Dest. Zipcode (4) / Package Weight (5) / Delivery Status (6) / Delivered At (7)
******************
1,195 W Oakland Ave,10:30 AM,Salt Lake City,84115,21,Delivered by truck #2,8:12AM
2,2530 S 500 E,EOD,Salt Lake City,84106,44,En route in truck #3,NA
3,233 Canyon Rd,EOD,Salt Lake City,84103,2,Delivered by truck #2,9:04AM
4,380 W 2880 S,EOD,Salt Lake City,84115,4,Delivered by truck #2,8:15AM
5,410 S State St,EOD,Salt Lake City,84111,5,Delivered by truck #2,8:42AM
6,3060 Lester St,10:30 AM,West Valley City,84119,88,En route in truck #3,NA
7,1330 2100 S,EOD,Salt Lake City,84106,8,Delivered by truck #2,8:27AM
8,300 State St,EOD,Salt Lake City,84103,9,Delivered by truck #2,8:45AM
9,300 State St,EOD,Salt Lake City,84103,2,En route in truck #3,NA
10,600 E 900 South,EOD,Salt Lake City,84105,1,Delivered by truck #2,8:54AM
11,2600 Taylorsville Blvd,EOD,Salt Lake City,84118,1,En route in truck #2,NA
12,3575 W Valley Central Station bus Loop,EOD,West Valley City,84119,1,Delivered by truck #2,9:28AM
13,2010 W 500 S,10:30 AM,Salt Lake City,84104,2,Delivered by truck #1,8:54AM
14,4300 S 1300 E,10:30 AM,Millcreek,84117,88,Delivered by truck #1,8:18AM
15,4580 S 2300 E,9:00 AM,Holladay,84117,4,Delivered by truck #1,8:11AM
16,4580 S 2300 E,10:30 AM,Holladay,84117,88,Delivered by truck #1,8:11AM
17,3148 S 1100 W,EOD,Salt Lake City,84119,2,En route in truck #3,NA
18,1488 4800 S,EOD,Salt Lake City,84123,6,En route in truck #2,NA
19,177 W Price Ave,EOD,Salt Lake City,84115,37,Delivered by truck #1,9:20AM
20,3595 Main St,10:30 AM,Salt Lake City,84115,37,Delivered by truck #1,8:28AM
21,3595 Main St,EOD,Salt Lake City,84115,3,Delivered by truck #1,8:28AM
22,6351 South 900 East,EOD,Murray,84121,2,En route in truck #3,NA
23,5100 South 2700 West,EOD,Salt Lake City,84118,5,En route in truck #3,NA
24,5025 State St,EOD,Murray,84107,7,En route in truck #3,NA
25,5383 S 900 East #104,10:30 AM,Salt Lake City,84117,7,Delivered by truck #3,9:35AM
26,5383 S 900 East #104,EOD,Salt Lake City,84117,25,Delivered by truck #3,9:35AM
27,1060 Dalton Ave S,EOD,Salt Lake City,84104,5,En route in truck #3,NA
28,2835 Main St,EOD,Salt Lake City,84115,7,En route in truck #3,NA
29,1330 2100 S,10:30 AM,Salt Lake City,84106,2,Delivered by truck #2,8:27AM
30,300 State St,10:30 AM,Salt Lake City,84103,1,Delivered by truck #2,8:45AM
31,3365 S 900 W,10:30 AM,Salt Lake City,84119,1,En route in truck #3,NA
32,3365 S 900 W,EOD,Salt Lake City,84119,1,En route in truck #3,NA
33,2530 S 500 E,EOD,Salt Lake City,84106,1,En route in truck #3,NA
34,4580 S 2300 E,10:30 AM,Holladay,84117,2,Delivered by truck #1,8:11AM
35,1060 Dalton Ave S,EOD,Salt Lake City,84104,88,En route in truck #3,NA
36,2300 Parkway Blvd,EOD,West Valley City,84119,88,Delivered by truck #2,9:38AM
37,410 S State St,10:30 AM,Salt Lake City,84111,2,Delivered by truck #2,8:42AM
38,410 S State St,EOD,Salt Lake City,84111,9,Delivered by truck #2,8:42AM
39,2010 W 500 S,EOD,Salt Lake City,84104,9,Delivered by truck #1,8:54AM
40,380 W 2880 S,10:30 AM,Salt Lake City,84115,45,Delivered by truck #2,8:15AM

Truck 1 Total Distance: 26.2
Truck 2 Total Distance: 29.99999999999999
Truck 3 Total Distance: 3.79999999999999

Give me a package ID to search. If you would like all packages, type All. If you would like to quit, type Quit. All
Give me a time to search for the package(s) in the form hours:minutes AM/PM. 1:00 PM
```

```
Give me a package ID to search. If you would like all packages, type All. If you would like to quit, type Quit. All
Give me a time to search for the package(s) in the form hours:minutes AM/PM. 1:00 PM

Outputting Hash Table of Package(s) All at: 1:00 PM
******************
ID (0) / Dest. Address (1) / Required Delivery Time (2) / Dest. City (3)
Dest. Zipcode (4) / Package Weight (5) / Delivery Status (6) / Delivered At (7)
******************
1,195 W Oakland Ave,10:30 AM,Salt Lake City,84115,21,Delivered by truck #2,8:12AM
2,2530 S 500 E,EOD,Salt Lake City,84106,44,Delivered by truck #3,10:17AM
3,233 Canyon Rd,EOD,Salt Lake City,84103,2,Delivered by truck #2,9:04AM
4,380 W 2880 S,EOD,Salt Lake City,84115,4,Delivered by truck #2,8:15AM
5,410 S State St,EOD,Salt Lake City,84111,5,Delivered by truck #2,8:42AM
6,3060 Lester St,10:30 AM,West Valley City,84119,88,Delivered by truck #3,10:00AM
7,1330 2100 S,EOD,Salt Lake City,84106,8,Delivered by truck #2,8:27AM
8,300 State St,EOD,Salt Lake City,84103,9,Delivered by truck #2,8:45AM
9,410 S State St,EOD,Salt Lake City,84111,2,Delivered by truck #3,10:30AM
10,600 E 900 South,EOD,Salt Lake City,84105,1,Delivered by truck #2,8:54AM
11,2600 Taylorsville Blvd,EOD,Salt Lake City,84118,1,Delivered by truck #2,9:55AM
12,3575 W Valley Central Station bus Loop,EOD,West Valley City,84119,1,Delivered by truck #2,9:28AM
13,2010 W 500 S,10:30 AM,Salt Lake City,84104,2,Delivered by truck #1,8:54AM
14,4300 S 1300 E,10:30 AM,Millcreek,84117,88,Delivered by truck #1,8:18AM
15,4580 S 2300 E,9:00 AM,Holladay,84117,4,Delivered by truck #1,8:11AM
16,4580 S 2300 E,10:30 AM,Holladay,84117,88,Delivered by truck #1,8:11AM
17,3148 S 1100 W,EOD,Salt Lake City,84119,2,Delivered by truck #3,10:04AM
18,1488 4800 S,EOD,Salt Lake City,84123,6,Delivered by truck #2,9:51AM
19,177 W Price Ave,EOD,Salt Lake City,84115,37,Delivered by truck #1,9:20AM
20,3595 Main St,10:30 AM,Salt Lake City,84115,37,Delivered by truck #1,8:28AM
21,3595 Main St,EOD,Salt Lake City,84115,3,Delivered by truck #1,8:28AM
22,6351 South 900 East,EOD,Murray,84121,2,Delivered by truck #3,11:35AM
23,5100 South 2700 West,EOD,Salt Lake City,84118,5,Delivered by truck #3,11:09AM
24,5025 State St,EOD,Murray,84107,7,Delivered by truck #3,11:24AM
25,5383 S 900 East #104,10:30 AM,Salt Lake City,84117,7,Delivered by truck #3,9:35AM
26,5383 S 900 East #104,EOD,Salt Lake City,84117,25,Delivered by truck #3,9:35AM
27,1060 Dalton Ave S,EOD,Salt Lake City,84104,5,Delivered by truck #3,10:46AM
28,2835 Main St,EOD,Salt Lake City,84115,7,Delivered by truck #3,10:13AM
29,1330 2100 S,10:30 AM,Salt Lake City,84106,2,Delivered by truck #2,8:27AM
30,300 State St,10:30 AM,Salt Lake City,84103,1,Delivered by truck #2,8:45AM
31,3365 S 900 W,10:30 AM,Salt Lake City,84119,1,Delivered by truck #3,9:55AM
32,3365 S 900 W,EOD,Salt Lake City,84119,1,Delivered by truck #3,9:55AM
33,2530 S 500 E,EOD,Salt Lake City,84106,1,Delivered by truck #3,10:17AM
34,4580 S 2300 E,10:30 AM,Holladay,84117,2,Delivered by truck #1,8:11AM
35,1060 Dalton Ave S,EOD,Salt Lake City,84104,88,Delivered by truck #3,10:46AM
36,2300 Parkway Blvd,EOD,West Valley City,84119,88,Delivered by truck #2,9:38AM
37,410 S State St,10:30 AM,Salt Lake City,84111,2,Delivered by truck #2,8:42AM
38,410 S State St,EOD,Salt Lake City,84111,9,Delivered by truck #2,8:42AM
39,2010 W 500 S,EOD,Salt Lake City,84104,9,Delivered by truck #1,8:54AM
40,380 W 2880 S,10:30 AM,Salt Lake City,84115,45,Delivered by truck #2,8:15AM

Truck 1 Total Distance: 26.2
Truck 2 Total Distance: 34.400000000000006
Truck 3 Total Distance: 38.2
```

E. Part D (MIDDLE) plus the following screenshots:

BEGINNING:

```
============================================== RESTART: C:\Users\PC\Documents\C950\C950_Sean_McKnelly\main.py ======

Give me a package ID to search. If you would like all packages, type All. If you would like to quit, type Quit. All
Give me a time to search for the package(s) in the form hours:minutes AM/PM. 8:40 AM
```

END:

```
Truck 1 Total Distance: 26.2
Truck 2 Total Distance: 34.400000000000006
Truck 3 Total Distance: 38.2

Give me a package ID to search. If you would like all packages, type All. If you would like to quit, type Quit. Quit
>>>
```

F.

1. Two or more strengths of the algorithms:

1. **The greedy algorithm is easy to implement.**
2. **The greedy algorithm is scalable with minor alteration of code.**
3. **The greedy algorithm is easy for another coder to understand with basic DS&A knowledge.**

2. Verify that the algorithm used in the solution meets all requirements in the scenario:

Most scenario requirements demonstrated in part D.

For the assumptions:

- Each truck can carry a maximum of 16 packages, and the ID number of each package is unique.

```
if len(self.packageArray) < 16 and "10:30" in allPackagesArray.packageArray[index].deliveryTime:
```

```
if len(self.truck1.packageArray) < 16:
```

```
if len(self.truck2.packageArray) < 16:
```

```
if (len(self.truck3.packageArray) + len(self.truck3.wrongAddressPackages) < 16):
```

ID uniqueness shown by output in pt. D

- The trucks travel at an average speed of 18 miles per hour and have an infinite amount of gas with no need to stop.

```
# Maximum speed of the truck
self.MPH = 18

# Takes a starting time and totalDistanceTraveled and determines what time it is
def CalculateTime(self, time):
    totalTimeTraveled = self.totalDistanceTraveled / self.MPH
    deliveredAt = time + totalTimeTraveled
    return deliveredAt
```

- There are no collisions.

```
# Changes the status of a package from at the hub to "En Route"
def LoadPackage(self, lookUpID):
    hashValue = int(lookUpID) % 10
    for node in self.table[hashValue]:
        if int(lookUpID) == int(node[0]):
                node[6][0] = "En Route"
```

Three trucks and two drivers are available for deliveries. Each driver stays with the same truck as long as that truck is in service.

Truck 1 returns when it is empty to WGU then the driver begins route on truck 3. There are 3 trucks.

Drivers leave the hub no earlier than 8:00 a.m., with the truck loaded, and can return to the hub for packages if needed.

```
# Deliver the packages
trucks.DeliverPackages(hubMatrix, 8, hashTable)
```

The 8 represents 8 AM

• The delivery and loading times are instantaneous (i.e., no time passes while at a delivery or when moving packages to a truck at the hub). This time is factored into the calculation of the average speed of the trucks.

Calculated Accordingly

- There is up to one special note associated with a package.

```
self.specialNote = specialNote
```

• The delivery address for package #9, Third District Juvenile Court, is wrong and will be corrected at 10:20 a.m. WGUPS is aware that the address is incorrect and will be updated at 10:20 a.m. However, WGUPS does not know the correct address (410 S. State St., Salt Lake City, UT 84111) until 10:20 a.m.

```
def PutWrongAddressLast(self):
    for x in range(len(self.packageArray)):
        if "Wrong address" in self.packageArray[x].specialNote:
            temp = self.packageArray[x]
            self.packageArray[x] = self.packageArray[len(self.packageArray) - 1]
            self.packageArray[len(self.packageArray) - 1] = temp

def FixWrongAddress(self, hashTable):
    for package in self.wrongAddressPackages:
        if "Wrong address" in package.specialNote:
            package.address = "410 S State St"
            package.city = "Salt Lake City"
            package.state = "UT"
            package.zipcode = "84111"
            package.specialNote = ""
        hashTable.FixPackageAddress(package.ID, package.address, package.city, package.zipcode)
        self.packageArray.append(package)
        self.wrongAddressPackages.remove(package)



# Puts the wrong address at the end of the list, to make sure it doesn't get delivered before
# the address gets corrected
self.PutWrongAddressLast()
```

- The distances provided in the "WGUPS Distance Table" are equal regardless of the direction traveled.

Code does not account for differences in direction traveled.

- The day ends when all 40 packages have been delivered.

Shown in output pt. D

3. Identify two other named algorithms different from the hash table implemented that would fulfill the same requirements.

Nearest Neighbor algorithm

Genetic Algorithm

a. Describe how both algorithms identified in part F3 are different from the algorithm implemented.

Nearest Neighbor – Drawing from GeeksForGeeks (2024), while there are aspects that are similar in my code, the sorting by zipcode in my code does it sequentially, when it could have located the nearest zipcode by average distance within that zip code.

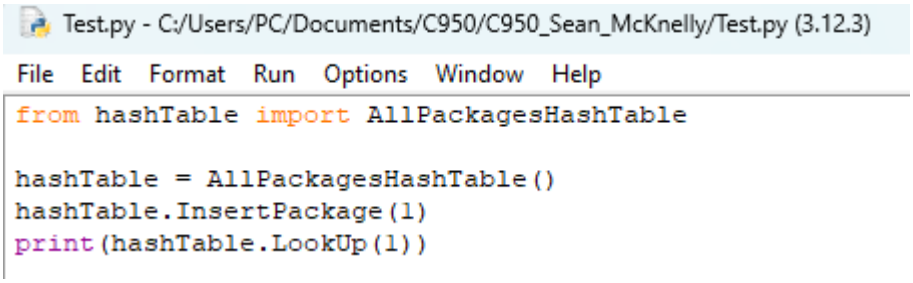
Genetic algorithm – Drawing from Ramez Shendy (2023), my code does not check different potential routes and select the most optimal. Genetic does.

G. Identify what you would do differently, other than the two algorithms identified in part F3, if you did this project again, including the details of the modifications that would be made.

I would use the package class within the hash table. I was under the impression I could not use a package class within the hash table, but after my meeting with Professor Denchy, I now know I can. This would have a better overall design than using an array. The package class would be essentially the same as package.py, but would add fields such as deliveredBy and status (en route, etc.).

I would also try to make the time complexity more efficient. For instance, there are probably more efficient ways to sort through the matrix of distances.

H. Verify that the data structure used in the solution meets all requirements in the scenario:




```
========== RESTART: C:/Users/PC/Documents/C950/C950_Sean_McKnelly/Test.py ==
195 W Oakland Ave, 10:30 AM, Salt Lake City, 84115, 21, At the hub, NA
```

1. Identify two other data structures that could have been used.
    - Dictionary
    - Array
    a. Dictionary would have been different because it would have built in the ID with the associated fields.
    b. Array would have been different because it would be less efficient to sort through to obtain the proper node.

I. Works Cited:

GeeksForGeeks. (2024, Jan. 25) *K-Nearest Neighbor (KNN) Algorithm*. GeeksForGeeks.org. https://www.geeksforgeeks.org/k-nearest-neighbours/

Shendy, Ramez. (2023, Aug. 5) *Traveling Salesman Problem (TSP) using Genetic Algorithm (Python).* Medium.com. https://medium.com/aimonks/traveling-salesman-problem-tsp-using-genetic-algorithm-fea640713758