A: Nearest Neighbor Algorithm

B1:

```
# view current location
# for(each package in packageList)
#     for(each string in addressList
#           return index of match for destination and current address
# if (hashTableDistance[matchIndex][matchIndex] < minimum
# load minimum package
```

B2: I used visual studio code. I used the Github integration for version control. I used the csv library to parse the csv files. I organized the program into different classes for organization. I used the Python debugger to help identify and fix bugs. I also used the Python interpreter.

B3: For the truck loading component the time complexity is *O(N^2)* because there are 2 nested “for” loops. For the parsing component, the time complexity is *O(N)* because it increases in processing power as the csv file gets larger. The time complexity of the entire program is *O(N^2).* The space complexity of the truck loading portion would be *O(N)*. The space complexity of the parsing component would also be *O(N).* This is because the data structures used increase at a linear rate as the amount of data increases. The space complexity of the entire program is *O(N)*.

B4: The program would struggle to scale and adapt as it is. The reason for this is that the exceptions (certain packages needing to be on certain trucks or delayed, etc) were handled in a more hard-coded way that would not apply to more or different exceptions. If the program was to scale or needed to be adapted, the exceptions would need to be handled in a more dynamic way. For the rest of the program like the parsing of the csv’s or loading the packages (without any exceptions), this would be very scalable and adaptable. It is just the exceptions that makes it not scalable/adaptable.

B5: The software is easy to maintain because it is sorted into different classes. Each class primarily manages itself and is called in a easy-to-read way in the Main file. Even the exception handling in the truck loading method, is well documented and written in a non-clunky way. Most everything that could be stowed away in a helper method was to improve readability.

B6: A strength of the hash table is that an element can be pulled very efficiently out of it using the “key” without the need to iterate and increase processing power. Another strength of a hash table is that the programmer can pick which key best suits their purposes. I used mostly index numbers in my programming project but it would be very easy if a different key needed to be used such as the address. A weakness of a hash table is that it adds more code to be able to iterate through it. In a list, one can simply iterate it using the indices built in but in a hash table, there needs to be a function to even search for an element and one has to figure out how they will iterate it (using numeric key-pairs or such). Another weakness of a hash table is that when there are a lot of collisions, it can become more inefficient.

C: Complete

C1: Complete.

C2: Complete.

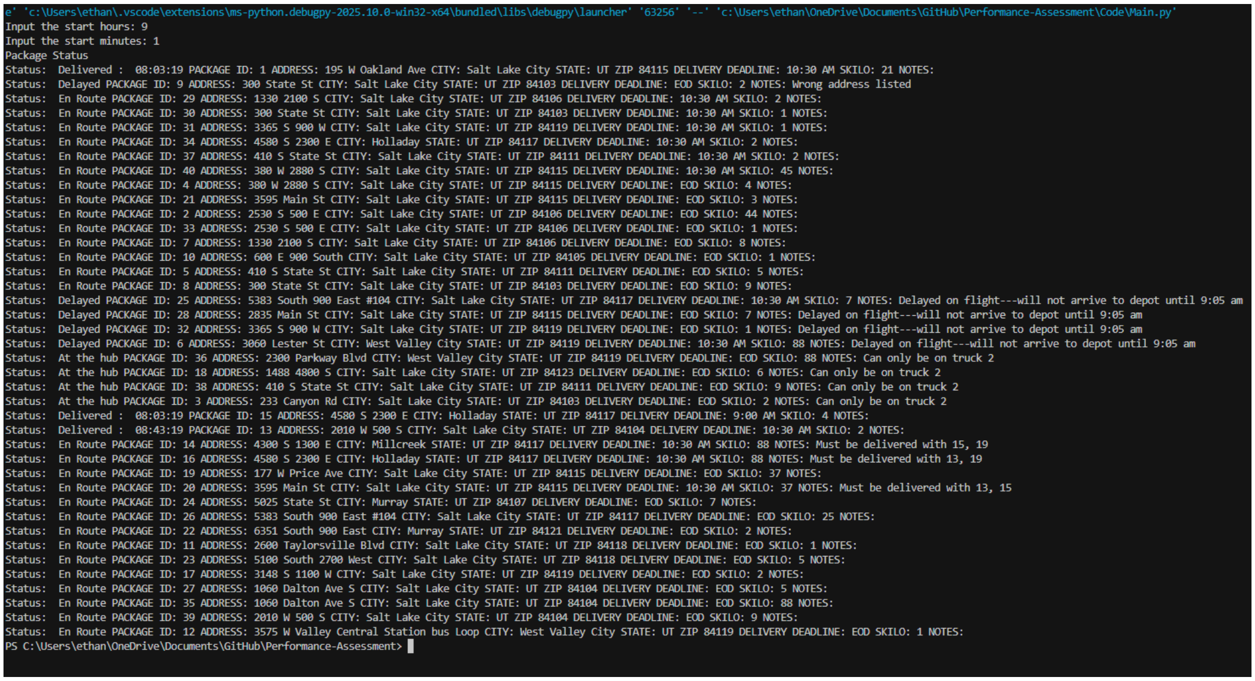
D: An object with instances stored in a hash table was used to store the package details.

D1: The object instance allows the data to be stored concisely in a way that makes sure the data stays together and cannot be mixed up. The hash table allows the package instances to be stored together in an organized manner. Using the package ID for the key value for each package, the programmer can pull out a specific package very easily without further iteration.

E: Complete. The hash table inserts the Package instances which contains all of the components.

F: The user can use the “search” function of the hash table to access the specific Package instance which they desire.

G1:



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Status:  En Route PACKAGE ID: 29 ADDRESS: 1330 2100 S CITY: Salt Lake City STATE: UT ZIP 84106 DELIVERY DEADLINE: 10:30 AM SKILO: 2 NOTES:
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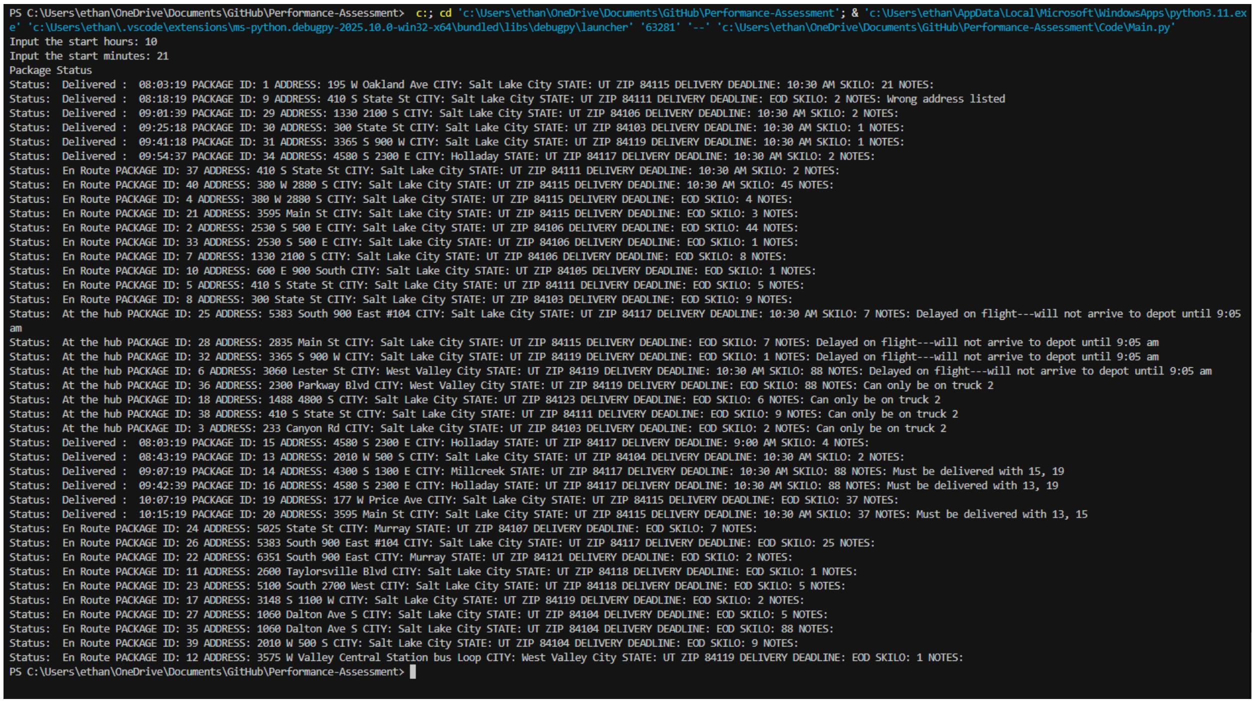

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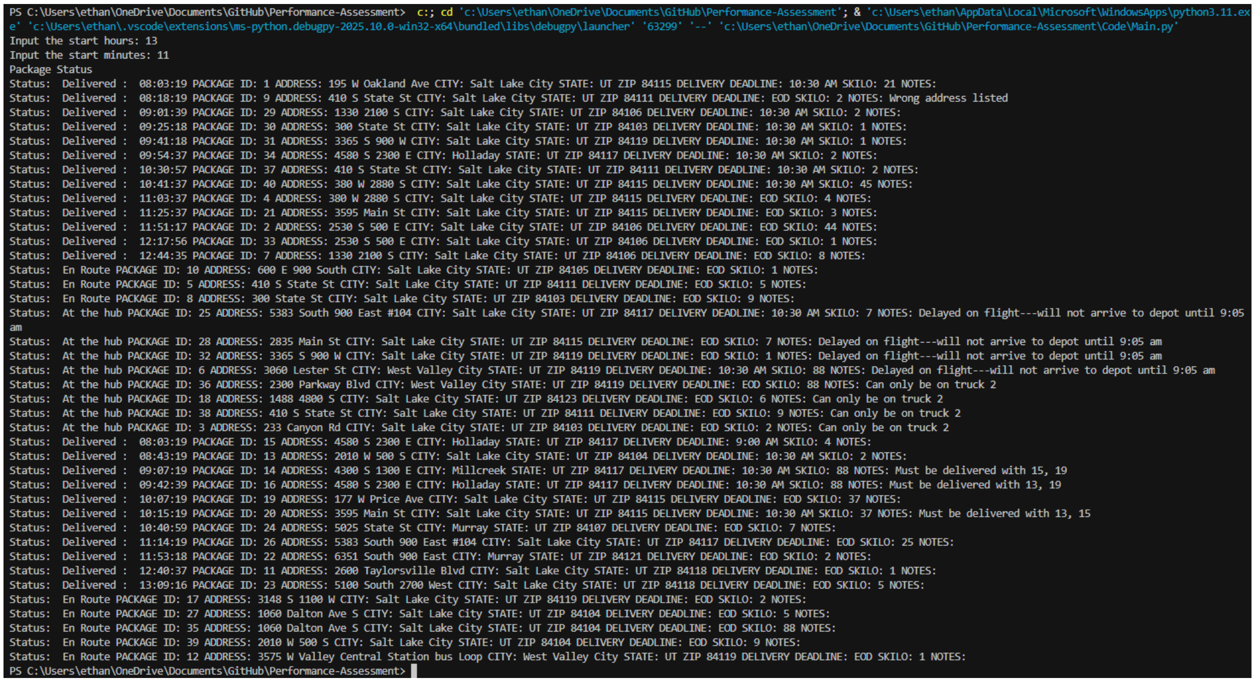

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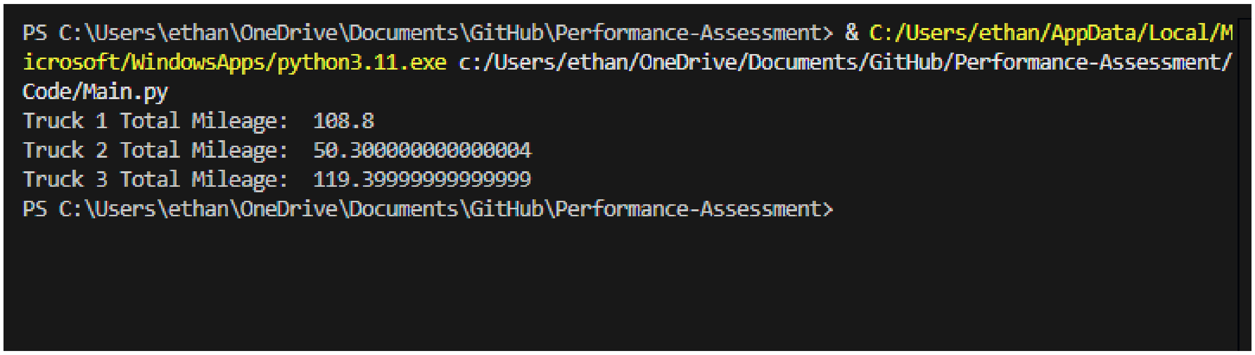
Status:  Delivered :  11:53:18 PACKAGE ID: 22 ADDRESS: 6351 South 900 East CITY: Murray STATE: UT ZIP 84121 DELIVERY DEADLINE: EOD SKILO: 2 NOTES:
Status:  Delivered :  12:40:37 PACKAGE ID: 11 ADDRESS: 2600 Taylorsville Blvd CITY: Salt Lake City STATE: UT ZIP 84118 DELIVERY DEADLINE: EOD SKILO: 1 NOTES:
Status:  Delivered :  13:09:16 PACKAGE ID: 23 ADDRESS: 5100 South 2700 West CITY: Salt Lake City STATE: UT ZIP 84118 DELIVERY DEADLINE: EOD SKILO: 5 NOTES:
Status:  En Route PACKAGE ID: 17 ADDRESS: 3148 S 1100 W CITY: Salt Lake City STATE: UT ZIP 84119 DELIVERY DEADLINE: EOD SKILO: 2 NOTES:
Status:  En Route PACKAGE ID: 27 ADDRESS: 1060 Dalton Ave S CITY: Salt Lake City STATE: UT ZIP 84104 DELIVERY DEADLINE: EOD SKILO: 5 NOTES:
Status:  En Route PACKAGE ID: 35 ADDRESS: 1060 Dalton Ave S CITY: Salt Lake City STATE: UT ZIP 84104 DELIVERY DEADLINE: EOD SKILO: 88 NOTES:
Status:  En Route PACKAGE ID: 39 ADDRESS: 2010 W 500 S CITY: Salt Lake City STATE: UT ZIP 84104 DELIVERY DEADLINE: EOD SKILO: 9 NOTES:
Status:  En Route PACKAGE ID: 12 ADDRESS: 3575 W Valley Central Station bus Loop CITY: West Valley City STATE: UT ZIP 84119 DELIVERY DEADLINE: EOD SKILO: 1 NOTES:
PS C:\Users\ethan\OneDrive\Documents\GitHub\Performance-Assessment>
```

H:



```
PS C:\Users\ethan\OneDrive\Documents\GitHub\Performance-Assessment> & C:/Users/ethan/AppData/Local/M
icrosoft/WindowsApps/python3.11.exe c:/Users/ethan/OneDrive/Documents/GitHub/Performance-Assessment/
Code/Main.py
Truck 1 Total Mileage:  108.8
Truck 2 Total Mileage:  50.300000000000004
Truck 3 Total Mileage:  119.39999999999999
PS C:\Users\ethan\OneDrive\Documents\GitHub\Performance-Assessment>
```

I: The nearest neighbor was a good algorithm for this project because it results in an optimal solution.

I1: If a decision is made on which package is closest, that will result in a shorter time total for all the packages. The nearest neighbor algorithm is also a simple algorithm to implement.

I2: Complete

I3: Two other algorithms I could have used were the dijkstra algorithm and also dynamic programming.

I3a: The dijkstra algorithm is different from the nearest neighbor because it is not a heuristic, it will guarantee an optimal result by looking at the shortest distance from every possible node. It is typically used for creating a single path, not a bunch of little paths like what this task asked for. The nearest neighbor algorithm only makes local decisions. Dynamic programming is different because rather than making local decisions, it solves the problem recursively and works using a bottoms up approach and memoization, storing all the previous results so it can compare them.

J: If I did this project again, I would do more planning early on about how I would handle the exceptions. That was the piece that made the code more messy than I would have liked.

K1a: For the data structure itself, the time needed to do a lookup function does not change at all. It is constant because the hash table uses a key pair so it does not need to iterate.

K1b: The space would be linear because it increases evenly as the amount of packages increases.

K1c: Changes in the number of trucks and number of cities would also not change the amount of time or space needed anymore than in a linear fashion because the hash table that contains the packages and distances would work the same. The list that is used to contain the address would increase in a linear fashion as well. The package list that contains the packages loaded in each truck would only increase in a linear fashion as well.

K2: Dictionary, lists of lists.

K2a: A dictionary would be similar but while it uses a key-pair, it would not be as structured as the hash table. The dictionary uses keys to map to values. The hash table stores the key-value pairs using hashing techniques. The dictionary is also more abstracted in how it works. The hash table has explicit methods that are defined in the project. The list of lists would be able to store a lot of data but iteration would be required, adding to the time complexity. The list of lists provides a sort of matrix while the hash table simply has key-value pairs. The list of lists would also keep track of the order of the elements while the hash table does not.

L: N/A

M: Complete.