Algorithm Overview

D. All Package Status Screenshots

All Package Check at 9:00


```
(.venv) PS C:\Users\User\PycharmProjects\C950_dsa2> python .\main.py
WGUPS Delivery Tracking
The total mileage: 119.5
===================
Enter the time of day in format 'HH:MM' at which you want to check the status: 9:00
==========
1. View status of all packages.
2. View status of a single package.
3. View status of packages by truck.
4. View packages by status.
5. View total mileage at the entered time
Input the number corresponding to your option(1-5) and press enter: 1
-------------------
Package 7: loaded.        Truck: 3        Departure Time: 10:20:00        Destination: 1330 2100 S        Deadline: EOD
Package 12: loaded.       Truck: 3        Departure Time: 10:20:00        Destination: 3575 W Valley Central Station bus Loop     Deadline: EOD
Package 21: loaded.       Truck: 3        Departure Time: 10:20:00        Destination: 3595 Main St        Deadline: EOD
Package 30: on its way.        Truck: 1        Departure Time: 8:00:00        Destination: 300 State St        Deadline: 10:30 AM
Package 9: loaded.        Truck: 3        Destination: 300 State St        Deadline: EOD
Package 14: delivered.    Truck: 1        Departure Time: 8:00:00        Destination: 4300 S 1300 E        Deadline: 10:30 AM        Delivery: 8:06:20
Package 23: loaded.       Truck: 3        Departure Time: 10:20:00        Destination: 5100 South 2700 West        Deadline: EOD
Package 32: delayed.      Truck: 2        Destination: 3365 S 900 W        Deadline: EOD
Package 16: delivered.    Truck: 1        Departure Time: 8:00:00        Destination: 4580 S 2300 E        Deadline: 10:30 AM        Delivery: 8:13:00
Package 25: delayed.      Truck: 2        Destination: 5383 South 900 East #104   Deadline: 10:30 AM
Package 34: delivered.    Truck: 1        Departure Time: 8:00:00        Destination: 4580 S 2300 E        Deadline: 10:30 AM        Delivery: 8:13:00
Package 2: loaded.        Truck: 3        Departure Time: 10:20:00        Destination: 2530 S 500 E        Deadline: EOD
Package 18: loaded.       Truck: 2        Departure Time: 9:05:00        Destination: 1488 4800 S        Deadline: EOD
Package 27: loaded.       Truck: 3        Departure Time: 10:20:00        Destination: 1060 Dalton Ave S        Deadline: EOD
Package 36: loaded.       Truck: 2        Departure Time: 9:05:00        Destination: 2300 Parkway Blvd        Deadline: EOD
Package 4: loaded.        Truck: 3        Departure Time: 10:20:00        Destination: 380 W 2880 S        Deadline: EOD
Package 29: delivered.    Truck: 1        Departure Time: 8:00:00        Destination: 1330 2100 S        Deadline: 10:30 AM        Delivery: 8:50:00
Package 38: loaded.       Truck: 2        Departure Time: 9:05:00        Destination: 410 S State St        Deadline: EOD
Package 6: delayed.       Truck: 2        Destination: 3060 Lester St        Deadline: 10:30 AM
Package 11: loaded.       Truck: 3        Departure Time: 10:20:00        Destination: 2600 Taylorsville Blvd        Deadline: EOD
Package 20: delivered.    Truck: 1        Departure Time: 8:00:00        Destination: 3595 Main St        Deadline: 10:30 AM        Delivery: 8:29:40
Package 8: loaded.        Truck: 3        Departure Time: 10:20:00        Destination: 300 State St        Deadline: EOD
Package 13: on its way.        Truck: 1        Departure Time: 8:00:00        Destination: 2010 W 500 S        Deadline: 10:30 AM
Package 22: loaded.       Truck: 3        Departure Time: 10:20:00        Destination: 6351 South 900 East        Deadline: EOD
Package 31: on its way.        Truck: 1        Departure Time: 8:00:00        Destination: 3365 S 900 W        Deadline: 10:30 AM
Package 40: delivered.    Truck: 1        Departure Time: 8:00:00        Destination: 380 W 2880 S        Deadline: 10:30 AM        Delivery: 8:37:00
Package 15: delivered.    Truck: 1        Departure Time: 8:00:00        Destination: 4580 S 2300 E        Deadline: 9:00 AM        Delivery: 8:13:00
```



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Package 15: delivered.    Truck: 1        Departure Time: 8:00:00        Destination: 4580 S 2300 E        Deadline: 9:00 AM        Delivery: 8:13:00
Package 24: loaded.       Truck: 3        Departure Time: 10:20:00        Destination: 5025 State St        Deadline: EOD
Package 33: loaded.       Truck: 3        Departure Time: 10:20:00        Destination: 2530 S 500 E        Deadline: EOD
Package 1: delivered.     Truck: 1        Departure Time: 8:00:00        Destination: 195 W Oakland Ave        Deadline: 10:30 AM        Delivery: 8:40:40
Package 17: loaded.       Truck: 3        Departure Time: 10:20:00        Destination: 3148 S 1100 W        Deadline: EOD
Package 26: loaded.       Truck: 3        Departure Time: 10:20:00        Destination: 5383 South 900 East #104   Deadline: EOD
Package 35: loaded.       Truck: 3        Departure Time: 10:20:00        Destination: 1060 Dalton Ave S        Deadline: EOD
Package 3: loaded.        Truck: 2        Departure Time: 9:05:00        Destination: 233 Canyon Rd        Deadline: EOD
Package 19: delivered.    Truck: 1        Departure Time: 8:00:00        Destination: 177 W Price Ave        Deadline: EOD   Delivery: 8:31:20
Package 28: delayed.      Truck: 2        Destination: 2835 Main St        Deadline: EOD
Package 37: on its way.        Truck: 1        Departure Time: 8:00:00        Destination: 410 S State St        Deadline: 10:30 AM
Package 5: loaded.        Truck: 2        Departure Time: 9:05:00        Destination: 410 S State St        Deadline: EOD
Package 10: loaded.       Truck: 2        Departure Time: 9:05:00        Destination: 600 E 900 South        Deadline: EOD
Package 39: loaded.       Truck: 2        Departure Time: 9:05:00        Destination: 2010 W 500 S        Deadline: EOD
-------------------
(.venv) PS C:\Users\User\PycharmProjects\C950_dsa2>
```

All package check at 10:08am

```
Terminal    Local  ×  +  ∨

(.venv) PS C:\Users\User\PycharmProjects\C950_dsa2> python .\main.py
WGUPS Delivery Tracking
The total mileage: 119.5
====================
Enter the time of day in format 'HH:MM' at which you want to check the status: 10:08
==========
1. View status of all packages.
2. View status of a single package.
3. View status of packages by truck.
4. View packages by status.
5. View total mileage at the entered time
Input the number corresponding to your option(1-5) and press enter: 1
--------------------
Package 7: loaded.       Truck: 3       Departure Time: 10:20:00      Destination: 1330 2100 S        Deadline: EOD
Package 12: loaded.      Truck: 3       Departure Time: 10:20:00      Destination: 3575 W Valley Central Station bus Loop    Deadline: EOD
Package 21: loaded.      Truck: 3       Departure Time: 10:20:00      Destination: 3595 Main St       Deadline: EOD
Package 30: delivered.   Truck: 1       Departure Time: 8:00:00       Destination: 300 State St       Deadline: 10:30 AM      Delivery: 9:07:40
Package 9: loaded.       Truck: 3       Destination: 300 State St      Deadline: EOD
Package 14: delivered.   Truck: 1       Departure Time: 8:00:00       Destination: 4300 S 1300 E      Deadline: 10:30 AM      Delivery: 8:06:20
Package 23: loaded.      Truck: 3       Departure Time: 10:20:00      Destination: 5100 South 2700 West      Deadline: EOD
Package 32: delivered.   Truck: 2       Departure Time: 9:05:00       Destination: 3365 S 900 W      Deadline: EOD   Delivery: 9:25:20
Package 16: delivered.   Truck: 1       Departure Time: 8:00:00       Destination: 4580 S 2300 E      Deadline: 10:30 AM      Delivery: 8:13:00
Package 25: delivered.   Truck: 2       Departure Time: 9:05:00       Destination: 5383 South 900 East #104   Deadline: 10:30 AM      Delivery: 9:05:00
Package 34: delivered.   Truck: 1       Departure Time: 8:00:00       Destination: 4580 S 2300 E      Deadline: 10:30 AM      Delivery: 8:13:00
Package 2: loaded.       Truck: 3       Departure Time: 10:20:00      Destination: 2530 S 500 E      Deadline: EOD
Package 18: delivered.   Truck: 2       Departure Time: 9:05:00       Destination: 1488 4800 S      Deadline: EOD   Delivery: 9:49:00
Package 27: loaded.      Truck: 3       Departure Time: 10:20:00      Destination: 1060 Dalton Ave S      Deadline: EOD
Package 36: delivered.   Truck: 2       Departure Time: 9:05:00       Destination: 2300 Parkway Blvd      Deadline: EOD   Delivery: 9:35:40
Package 4: loaded.       Truck: 3       Departure Time: 10:20:00      Destination: 380 W 2880 S      Deadline: EOD
Package 29: delivered.   Truck: 1       Departure Time: 8:00:00       Destination: 1330 2100 S      Deadline: 10:30 AM      Delivery: 8:50:00
Package 38: on its way.       Truck: 2       Departure Time: 9:05:00       Destination: 410 S State St      Deadline: EOD
Package 6: delivered.    Truck: 2       Departure Time: 9:05:00       Destination: 3060 Lester St      Deadline: 10:30 AM      Delivery: 9:30:20
Package 11: loaded.      Truck: 3       Departure Time: 10:20:00      Destination: 2600 Taylorsville Blvd      Deadline: EOD
Package 20: delivered.   Truck: 1       Departure Time: 8:00:00       Destination: 3595 Main St      Deadline: 10:30 AM      Delivery: 8:29:40
Package 8: loaded.       Truck: 3       Departure Time: 10:20:00      Destination: 300 State St      Deadline: EOD
Package 13: delivered.   Truck: 1       Departure Time: 8:00:00       Destination: 2010 W 500 S      Deadline: 10:30 AM      Delivery: 9:21:40
Package 22: loaded.      Truck: 3       Departure Time: 10:20:00      Destination: 6351 South 900 East      Deadline: EOD
Package 31: delivered.   Truck: 1       Departure Time: 8:00:00       Destination: 3365 S 900 W      Deadline: 10:30 AM      Delivery: 9:41:00
Package 40: delivered.   Truck: 1       Departure Time: 8:00:00       Destination: 380 W 2880 S      Deadline: 10:30 AM      Delivery: 8:37:00
Package 15: delivered.   Truck: 1       Departure Time: 8:00:00       Destination: 4580 S 2300 E      Deadline: 9:00 AM      Delivery: 8:13:00
```

```
Package 15: delivered.   Truck: 1       Departure Time: 8:00:00       Destination: 4580 S 2300 E      Deadline: 9:00 AM      Delivery: 8:13:00
Package 24: loaded.      Truck: 3       Departure Time: 10:20:00      Destination: 5025 State St      Deadline: EOD
Package 33: loaded.      Truck: 3       Departure Time: 10:20:00      Destination: 2530 S 500 E      Deadline: EOD
Package 1: delivered.    Truck: 1       Departure Time: 8:00:00       Destination: 195 W Oakland Ave      Deadline: 10:30 AM      Delivery: 8:40:40
Package 17: loaded.      Truck: 3       Departure Time: 10:20:00      Destination: 3148 S 1100 W      Deadline: EOD
Package 26: loaded.      Truck: 3       Departure Time: 10:20:00      Destination: 5383 South 900 East #104   Deadline: EOD
Package 35: loaded.      Truck: 3       Departure Time: 10:20:00      Destination: 1060 Dalton Ave S      Deadline: EOD
Package 3: on its way.   Truck: 2       Departure Time: 9:05:00       Destination: 233 Canyon Rd      Deadline: EOD
Package 19: delivered.   Truck: 1       Departure Time: 8:00:00       Destination: 177 W Price Ave      Deadline: EOD   Delivery: 8:31:20
Package 28: delivered.   Truck: 2       Departure Time: 9:05:00       Destination: 2835 Main St      Deadline: EOD   Delivery: 9:15:40
Package 37: delivered.   Truck: 1       Departure Time: 8:00:00       Destination: 410 S State St      Deadline: 10:30 AM      Delivery: 9:04:20
Package 5: on its way.   Truck: 2       Departure Time: 9:05:00       Destination: 410 S State St      Deadline: EOD
Package 10: on its way.       Truck: 2       Departure Time: 9:05:00       Destination: 600 E 900 South      Deadline: EOD
Package 39: on its way.       Truck: 2       Departure Time: 9:05:00       Destination: 2010 W 500 S      Deadline: EOD
--------------------
```

All Package Check at 13:00

```
====================
Enter the time of day in format 'HH:MM' at which you want to check the status: 13:00
==========
1. View status of all packages.
2. View status of a single package.
3. View status of packages by truck.
4. View packages by status.
5. View total mileage at the entered time
Input the number corresponding to your option(1-5) and press enter: 1
--------------------
Package 7: delivered.    Truck: 3      Departure Time: 10:20:00      Destination: 1330 2100 S         Deadline: EOD   Delivery: 10:43:20
Package 12: delivered.   Truck: 3      Departure Time: 10:20:00      Destination: 3575 W Valley Central Station bus Loop    Deadline: EOD   Delivery: 12:47:00
Package 21: delivered.   Truck: 3      Departure Time: 10:20:00      Destination: 3595 Main St        Deadline: EOD   Delivery: 10:26:40
Package 30: delivered.   Truck: 1      Departure Time: 8:00:00       Destination: 300 State St        Deadline: 10:30 AM      Delivery: 9:07:40
Package 9: delivered.    Truck: 3      Departure Time: 10:20:00      Destination: 410 S. State St., Salt Lake City, UT 84111       Deadline: EOD   Delivery: 10:20:00
Package 14: delivered.   Truck: 1      Departure Time: 8:00:00       Destination: 4300 S 1300 E       Deadline: 10:30 AM      Delivery: 8:06:20
Package 23: delivered.   Truck: 3      Departure Time: 10:20:00      Destination: 5100 South 2700 West        Deadline: EOD   Delivery: 12:22:00
Package 32: delivered.   Truck: 2      Departure Time: 9:05:00       Destination: 3365 S 900 W        Deadline: EOD   Delivery: 9:25:20
Package 16: delivered.   Truck: 1      Departure Time: 8:00:00       Destination: 4580 S 2300 E       Deadline: 10:30 AM      Delivery: 8:13:00
Package 25: delivered.   Truck: 2      Departure Time: 9:05:00       Destination: 5383 South 900 East #104   Deadline: 10:30 AM      Delivery: 9:05:00
Package 34: delivered.   Truck: 1      Departure Time: 8:00:00       Destination: 4580 S 2300 E       Deadline: 10:30 AM      Delivery: 8:13:00
Package 2: delivered.    Truck: 3      Departure Time: 10:20:00      Destination: 2530 S 500 E        Deadline: EOD   Delivery: 10:38:00
Package 18: delivered.   Truck: 2      Departure Time: 9:05:00       Destination: 1488 4800 S        Deadline: EOD   Delivery: 9:49:00
Package 27: delivered.   Truck: 3      Departure Time: 10:20:00      Destination: 1060 Dalton Ave S        Deadline: EOD   Delivery: 11:17:00
Package 36: delivered.   Truck: 2      Departure Time: 9:05:00       Destination: 2300 Parkway Blvd        Deadline: EOD   Delivery: 9:35:40
Package 4: delivered.    Truck: 3      Departure Time: 10:20:00      Destination: 380 W 2880 S        Deadline: EOD   Delivery: 10:32:00
Package 29: delivered.   Truck: 1      Departure Time: 8:00:00       Destination: 1330 2100 S        Deadline: 10:30 AM      Delivery: 8:50:00
Package 38: delivered.   Truck: 2      Departure Time: 9:05:00       Destination: 410 S State St       Deadline: EOD   Delivery: 10:28:20
Package 6: delivered.    Truck: 2      Departure Time: 9:05:00       Destination: 3060 Lester St       Deadline: 10:30 AM      Delivery: 9:30:20
Package 11: delivered.   Truck: 3      Departure Time: 10:20:00      Destination: 2600 Taylorsville Blvd    Deadline: EOD   Delivery: 12:20:40
Package 20: delivered.   Truck: 1      Departure Time: 8:00:00       Destination: 3595 Main St        Deadline: 10:30 AM      Delivery: 8:29:40
Package 8: delivered.    Truck: 3      Departure Time: 10:20:00      Destination: 300 State St        Deadline: EOD   Delivery: 11:01:00
Package 13: delivered.   Truck: 1      Departure Time: 8:00:00       Destination: 2010 W 500 S        Deadline: 10:30 AM      Delivery: 9:21:40
Package 22: delivered.   Truck: 3      Departure Time: 10:20:00      Destination: 6351 South 900 East       Deadline: EOD   Delivery: 11:58:00
Package 31: delivered.   Truck: 1      Departure Time: 8:00:00       Destination: 3365 S 900 W        Deadline: 10:30 AM      Delivery: 9:41:00
Package 40: delivered.   Truck: 1      Departure Time: 8:00:00       Destination: 380 W 2880 S        Deadline: 10:30 AM      Delivery: 8:37:00
Package 15: delivered.   Truck: 1      Departure Time: 8:00:00       Destination: 4580 S 2300 E       Deadline: 9:00 AM      Delivery: 8:13:00
Package 24: delivered.   Truck: 3      Departure Time: 10:20:00      Destination: 5025 State St        Deadline: EOD   Delivery: 11:47:40
Package 33: delivered.   Truck: 3      Departure Time: 10:20:00      Destination: 2530 S 500 E        Deadline: EOD   Delivery: 10:38:00
Package 1: delivered.    Truck: 1      Departure Time: 8:00:00       Destination: 195 W Oakland Ave        Deadline: 10:30 AM      Delivery: 8:40:40
```

```
Package 1: delivered.    Truck: 1      Departure Time: 8:00:00       Destination: 195 W Oakland Ave        Deadline: 10:30 AM      Delivery: 8:40:40
Package 17: delivered.   Truck: 3      Departure Time: 10:20:00      Destination: 3148 S 1100 W        Deadline: EOD   Delivery: 11:32:20
Package 26: delivered.   Truck: 3      Departure Time: 10:20:00      Destination: 5383 South 900 East #104   Deadline: EOD   Delivery: 10:20:00
Package 35: delivered.   Truck: 3      Departure Time: 10:20:00      Destination: 1060 Dalton Ave S        Deadline: EOD   Delivery: 11:17:00
Package 3: delivered.    Truck: 2      Departure Time: 9:05:00       Destination: 233 Canyon Rd        Deadline: EOD   Delivery: 10:31:40
Package 19: delivered.   Truck: 1      Departure Time: 8:00:00       Destination: 177 W Price Ave       Deadline: EOD   Delivery: 8:31:20
Package 28: delivered.   Truck: 2      Departure Time: 9:05:00       Destination: 2835 Main St        Deadline: EOD   Delivery: 9:15:40
Package 37: delivered.   Truck: 1      Departure Time: 8:00:00       Destination: 410 S State St        Deadline: 10:30 AM      Delivery: 9:04:20
Package 5: delivered.    Truck: 2      Departure Time: 9:05:00       Destination: 410 S State St        Deadline: EOD   Delivery: 10:28:20
Package 10: delivered.   Truck: 2      Departure Time: 9:05:00       Destination: 600 E 900 South       Deadline: EOD   Delivery: 10:41:00
Package 39: delivered.   Truck: 2      Departure Time: 9:05:00       Destination: 2010 W 500 S        Deadline: EOD   Delivery: 10:17:40
--------------------
```

E. Successful Completion of code including total mileage

```
(.venv) PS C:\Users\User\PycharmProjects\C950_dsa2> python .\main.py
WGUPS Delivery Tracking
The total mileage: 119.5
====================
Enter the time of day in format 'HH:MM' at which you want to check the status:
```

Alternatively –

```
====================
Enter the time of day in format 'HH:MM' at which you want to check the status: 14:00
==========
1. View status of all packages.
2. View status of a single package.
3. View status of packages by truck.
4. View packages by status.
5. View total mileage at the entered time
Input the number corresponding to your option(1-5) and press enter: 5
----------
Mileage at EOD:
Total Mileage: 119.5
Truck 1: 34.0
Truck 2: 33.8
Truck 3: 51.7
----------
Mileage as of 14:00:00:
Total Mileage: 119.5
Truck 1: 34.0
Truck 2: 33.8
Truck 3: 51.7
(.venv) PS C:\Users\User\PycharmProjects\C950_dsa2>
```

Big O Notations

Address.py

Method, Line	Time complexity	Space complexity
Init, 3	O(1)	O(1)
get_location, 8	O(1)	O(1)
get_address, 12	O(1)	O(1)

CSVReader.py

Method, Line	Time complexity	Space complexity
load_addresses, 11	O(N)	O(N)
load_packages, 28	O(N)	O(N)
load_distances, 65	O(NxM)	O(NxM)

HashTable.py

Method, Line	Time complexity	Space complexity
Init, 2	O(1)	O(1)
Hash, 7	O(N)	O(1)
Set_package, 18	O(N+M) N = length of key M = num items in hashtable	O(M)
Get_package, 36	O(N+M)	O(1)
Get_all_packages, 49	O(M)	O(M)

Helpers.py

Method, Line	Time complexity	Space complexity
load_package_on_truck, 6	O(1)	O(1)
load_delayed_package_on_truck, 26	O(1)	O(1)
load_trucks_by_affinity, 46	O(N)	O(1)
load_trucks_by_EOD, 62	O(N)	O(1)
filter_packages_by_status, 77	O(N)	O(N)
filter_packages_by_status_with_time, 85	O(N)	O(N)
load_delayed_packages, 99	O(N)	O(N)
get_package_distance, 110	O(N)	O(1)
get_packages_with_distance, 132	O(N^2)	O(N)
sort_packages_by_distance, 138	O(NLogN)	O(N)
load_trucks_by_distance, 146	O(N^2)	O(N)
load_trucks, 166	O(N^2)	O(N)

get_nearest_package_id, 176	O(N^2)	O(1)
deliver_packages, 193	O(N^3)	O(1)

Package.py

Method, Line	Time complexity	Space complexity
Init, 5	O(1)	O(1)
Get_id, 24	O(1)	O(1)
Get_address, 28	O(1)	O(1)
Get_delivery_status, 36	O(1)	O(1)
get_truck_affinity, 48	O(1)	O(1)
get_truck_id, 52	O(1)	O(1)
check_status_against_time, 60	O(1)	O(1)
get_status, 77	O(1)	O(1)

Truck.py

Method, Line	Time complexity	Space complexity
Init, 2	O(1)	O(N)
Get_id, 19	O(1)	O(1)
load_package, 23	O(1)	O(1)
deliver_package, 27	O(N)	O(N)
get_current_address, 33	O(1)	O(1)
get_total_capacity, 37	O(1)	O(1)
get_available_capacity, 45	O(1)	O(1)
get_reserved_capacity, 53	O(1)	O(1)
get_package_ids, 57	O(1)	O(1)
get_delivered_package_ids, 61	O(1)	O(1)
get_departure_time, 69	O(1)	O(1)

add_mileage_timestamp, 86	O(1)	O(1)
get_final_mileage, 92	O(N)	O(1)
get_mileage_at, 99	O(N)	O(1)

F.

1. Describe **two or more** strengths of the algorithm used in the solution.

Loading Trucks - The algorithm first prioritizes the packages by their delivery constraints in notes, their deadlines ("EOD"), and the special cases of delayed packages. The method "load_trucks" uses three helper methods "load_trucks_by_affinity" (an additional column in csv), "load_trucks_by_EOD" and "load_trucks_by_distance" to sort and load packages in a way that adheres to the global and local constraints. The priority is to minimize the local constraints in hope that the global constraints would be automatically adhered to as a result.

Delivery routing – I used nearest neighbor first algorithm. Once the packages are loaded, the method "deliver_packages" is called. This method in turn calls the "get_nearest_package_id" which gets the nearest neighbor. In these methods, the overall approach is that the current location is compared with the addresses of all the remaining undelivered packages and the address which is nearest to the current location is selected as the next package to be delivered. This heuristic does not guarantee an absolute minimum total mileage but focuses on minimizing the local distances with the aim to reduce the final total mileage.

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

Delayed packages – the program correctly handles delayed packages by using "load_delayed_packages" and "load_delayed_package_on_truck". Despite the packages being delayed, their delivery is still prioritized by reserving a spot for them programmatically.

Truck departures – The delivery route is coded to account for a return trip to the hub after all the packages are delivered. The departure of truck 1 is the earliest possible. The departure of truck 2 is next as soon as the delayed packages arrive. Finally, the departure of the truck 3 is the max of (10:20am – address change, the earliest availability of a driver from truck 1 or 2). So the logical constraint of the drivers is also respected by scheduling truck departures.

Deadlines—The algorithm first loads all the EOD packages in truck 3, which can afford to leave last. Complimenting this, truck 1 is loaded with the fewest packages so that it can return quickly and allow the departure of truck 3. All the packages were delivered before their deadline.

Efficient routing – While nearest neighbor algorithm can not guarantee the lowest possible route, it still uses distance-based sorting to optimize the delivery route to a certain extent. This helps keep the total mileage at 119.5.

3. Identify **two** other named algorithms that are different from the algorithm implemented in the solution and would meet *all* requirements in the scenario.

a. Describe how *both* algorithms identified in part F3 are different from the algorithm used in the solution.

i) Brute force algorithm: The first solution that I thought of was indeed the brute force algorithm. As heavy on computer resources it is, it's still way cheaper for a smal logistics company which might prioritize saving fuel costs and time. They might not mind spending more on computing if it helps them save hours with the delivery. The issue is that it's not a scalable solution. Its time complexity is N! as compared to nearest neighbor which is N^2. (Kuo, 2024)

ii) The Genetic algorithm: This algorithm uses some randomization and intentional elimination of solutions that aren't helpful. Potential solutions evolve over iterations to find the best of the choices. It does not give the absolute best path. It uses fitness calculation, selection, crossover, mutation, replacement, and finally termination to deliver a near-optimal solution. Unlike my algorithm, this method focuses on the global constraint of a low overall mileage. (Jamdade, 2023)

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

1) My truck 3 departs at 10:20 because it waits for the later event between (correction in address of a package and availability of a returning truck driver). I think the truck is free to depart as soon as a driver is available as long as I could hold on to the package and not deliver it before 10:20. The implementation would require a Boolean attribute in the package class. If it's true, it shouldn't be considered in the nearest neighbor algorithm but it can still be loaded on a truck

that has departed. As soon as the address change is done, the Boolean attribute can be turned false and from the next iteration, the said package could be considered for delivery.

2) While loading the trucks, I would try to cluster nearer packages in the same truck. I could do it by selecting 3 equidistant start nodes (that will go in different trucks). Then I could call the nearest neighbor algorithm on those nodes. Currently, the program uses the nearest neighbor algorithm for the packages already loaded on the truck. But in this alternate approach, the entire universe of packages would be available to be clustered. That is of course after the constraints of each package note.

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

The hash table implementation does meet all the requirements. It has a setter method which doubles down as an update/insert method. It also has a getter method which allows for easy search. The only time complexity would be because of having multiple packages in a single slot. That's not a problem though because while scaling up, the hashtable's number of slots could be increased to a larger prime number to reduce, if not avoid, collisions. The hash table enabled the delivery of all packages with a total mileage of 119.5.

1. Identify **two** other data structures that could meet the same requirements in the scenario.
a. Describe how *each* data structure identified in H1 is different from the data structure used in the solution.

I could've used alternative storages of package values.

Binary search tree – It's a powerful self adjusting data structure. While the retrieval of packages wouldn't be as efficient as it was with a hashtable, it would still be highly efficient. In my hashtable, I used string ID's that went through a hash function and got translated to the index/slot of the hash table. In a binary search tree, I'd have to use integer ID's to allow for self balancing inserts. (Nelson-Fromm, n.d.))

Priority queue – Using a priority queue would involve a lot of refactoring of the programs but it sure would make loading the trucks and eventually delivering them, easier. This would allow EOD items to be delivered last. It would also allow for delayed packages to be treated accordingly. A priority queue does sacrifice time complexity for the feature of priority based processing.

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