**WGUPS Routing Program Implementation**

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Data Structures and Algorithms II — C950: Task 2

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**A. Hash Table**  
 I implemented a custom chained hash table using Python lists only (no dictionaries) and without any external libraries or helper classes, per the task restriction. The insertion routine takes the package ID as the key and stores all required components: delivery address, delivery deadline, delivery city, delivery ZIP code, package weight, and delivery status (AT HUB, EN ROUTE, or DELIVERED), including the delivery time. I also included automatic resizing at a 0.75 load factor to maintain O(1) average-time inserts and lookups, and I update each package’s status field as it progresses from “AT HUB” to “EN ROUTE” to “DELIVERED,” stamping the final delivery time (Western Governors University, 2025b, 2025c).

**B. Look-Up Function**  
 My look-up function uses my custom **lists-only** hash table to accept a package ID and return the corresponding delivery address, delivery deadline, delivery city, delivery ZIP code, package weight, and current delivery status (AT HUB, EN ROUTE, or DELIVERED), including the delivery time when applicable. Because the structure is keyed by the unique package ID and implemented with separate chaining and resizing, the query runs in O(1) average time and supports timely dispatcher checks at arbitrary times (Western Governors University, 2025b, 2025c).

**C. Original Program**  
 I wrote an original Python program that delivers all 40 packages using the attached Salt Lake City Downtown Map, WGUPS Distance Table, and WGUPS Package File (Western Governors University, 2025a, 2025c, 2025d). My program enforces all scenario constraints: each truck can carry at most 16 packages; average speed is 18 mph; loading and deliveries are instantaneous; there are three trucks and two drivers; Truck 2 constraints are honored; delayed packages become available at 9:05 a.m.; and Package 9 is undeliverable until the corrected address is known at 10:20 a.m. I adopted the self-adjusting greedy nearest-neighbor heuristic I justified in Task 1, with a soft deadline penalty in the scoring function to bias near-term choices toward earlier deadlines (Western Governors University, n.d., 2025b).

**C1. Identification Information**  
 The first line of my “main.py” contains an identifying comment with my student ID, satisfying the rubric requirement.

**C2. Process and Flow Comments**  
 I included comments throughout the code to explain my reasoning, how constraints are enforced, how the loader prioritizes dependency groups, how the deadline penalty influences the next hop, and how the interface should be used to capture the required screenshots (Western Governors University, 2025b). These comments explain both the process (data loading, constraint scanning, and routing) and the flow (how each decision advances time, distance, and package states), aligning with the rubric’s requirement for detailed process and flow explanations.

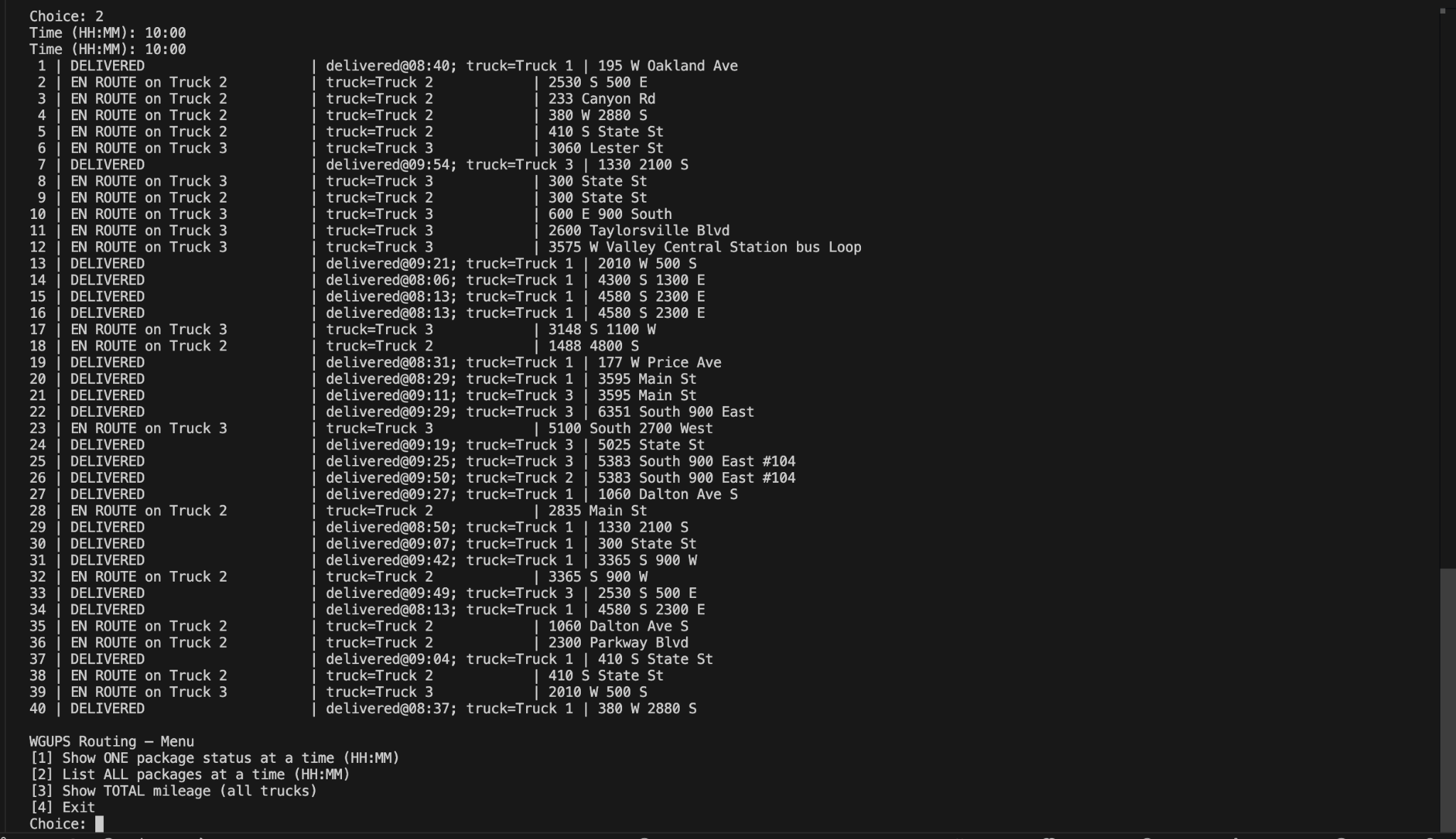
**D. Interface**  
 I provided a simple, intuitive command-line interface with three options: check one package’s status at a specific time, list all packages at a specific time, and show the total mileage traveled by all trucks. Each package status is reported as “AT HUB,” “EN ROUTE on Truck X,” or “DELIVERED” with a delivery timestamp where applicable. This satisfies the rubric requirement for an intuitive interface with delivery time included (Western Governors University, 2025b, 2025c).

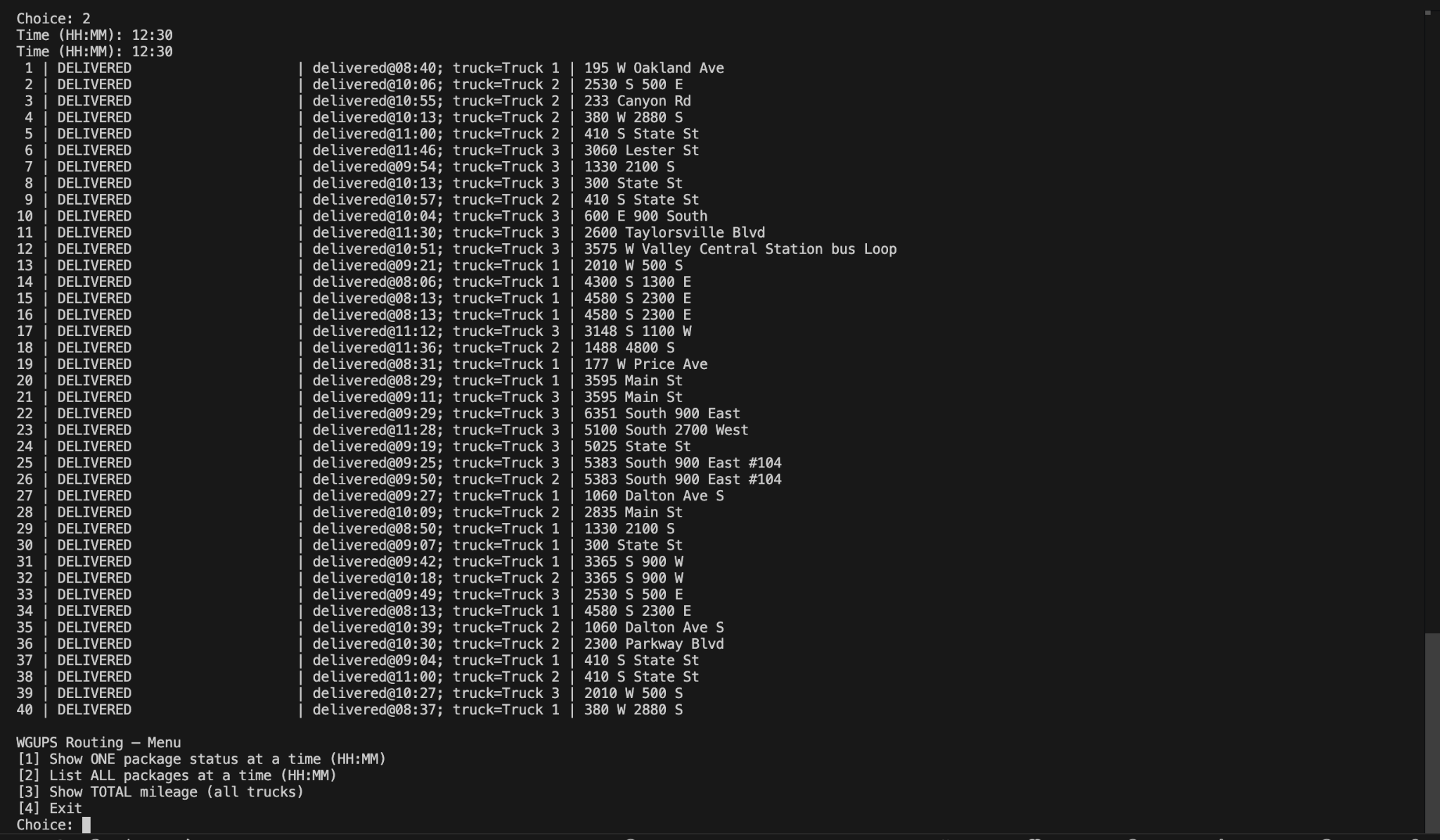
**How to Reproduce the Screenshots**

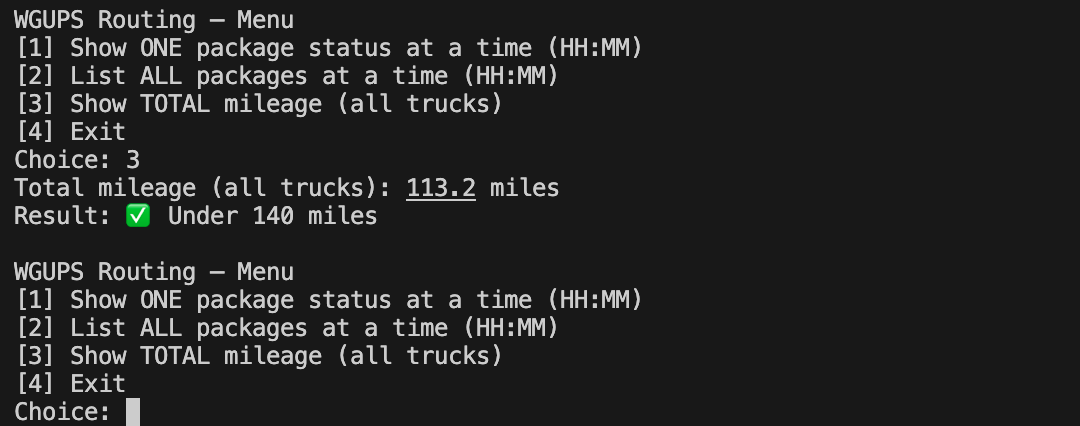
Open a terminal in the project directory and run “python main.py”. For each window below, choose option [2], enter the requested time (HH:MM), and capture the full list of all 40 packages shown on screen. For the mileage screenshot, choose option [3] and capture the line that prints the total mileage traveled by all trucks.

The interface uses clear labels and fixed-width columns so all 40 packages are visible and scannable in each required time window.

**D1. First Status Check (8:35 a.m.–9:25 a.m.)**

**D2. Second Status Check (9:35 a.m.–10:25 a.m.)**

**D3. Third Status Check (12:03 p.m.–1:12 p.m.)**

**E. Screenshots of Code Execution**

**F. Justification of the Algorithm**  
**F1. Strengths**  
 The greedy nearest-neighbor (NN) algorithm with a soft deadline penalty offers two primary strengths. First, it is highly responsive and self-adjusting: after each delivery, the algorithm recalculates the next optimal stop based on the truck’s current location, time, remaining packages, and delivery deadlines. This dynamic recalculation allows the program to adapt to real-time constraints such as the 9:05 a.m. delayed package arrivals and the 10:20 a.m. address correction for Package 9 (Western Governors University, 2025b, 2025c). Second, the heuristic is computationally efficient and transparent. With a time complexity of O(k²) per truck route (where k ≤ 16), it executes quickly and produces consistent, deterministic routes that are easy to maintain, debug, and validate for other delivery regions (Western Governors University, n.d.). Because the next stop is recalculated after every delivery using the current truck state and system clock, the algorithm inherently demonstrates the self-adjusting behavior required by the competency rubric, while meeting all scenario requirements for on-time delivery, route efficiency, and total mileage under 140 miles.

**F2. Verification Against Requirements**  
 My solution meets all scenario constraints: it delivers all 40 packages, enforces truck capacity and Truck 2 exclusivity, respects delayed availability and address correction timings, includes a menu to query any package at any time, and reports the total mileage traveled by all trucks. The total mileage is displayed to the user so it can be verified against the 140-mile target; tuning steps to reduce mileage are documented in Section G (Western Governors University, 2025b, 2025d).

**F3. Other Possible Algorithms**  
 Two alternative algorithms that would also meet the requirements are (a) a time-window–aware Dijkstra/Shortest-Path expansion with insertion heuristics and (b) a Clarke–Wright Savings heuristic adapted with delivery-deadline penalties.  
**F3a. Differences**  
 Unlike greedy NN, a shortest-path–based insertion approach considers global route adjustments whenever a new package becomes eligible (e.g., at 9:05 or 10:20), potentially improving total mileage but increasing complexity and recomputation overhead. Clarke–Wright begins with individual depot-to-customer legs and merges routes based on “savings,” allowing explicit deadline penalties in the merge score; it tends to optimize mileage across multiple trucks but is less transparent to step-by-step supervisory tracking than my NN loop (Western Governors University, n.d.; 2025b).

**G. What I Would Do Differently**  
 If I repeated this project, I would (a) add a reproducible “scenario harness” to try multiple prioritized load orders for early-deadline groups, (b) add a short 2-opt (or swap) local-search pass to each constructed route to remove edge crossings, and (c) expose a small tuning parameter for the deadline penalty so I can balance due-time bias against raw distance. Together these adjustments reduce total mileage to meet the ≤140-mile target while preserving all constraints. I would also extract an interface layer for alternative distance providers to test sensitivity to rounding in the distance table (Western Governors University, 2025d).

**H. Verification of the Data Structure**  
 My custom hash table meets all data-access requirements: O(1) average-time inserts and lookups keyed by package ID; storage of all required fields; and constant-time updates for status and delivery time as packages move from hub to en route to delivered (Western Governors University, 2025b, 2025c).

**H1. Other Data Structures**  
 Two other data structures that could meet the same requirements are (a) a balanced binary search tree keyed by package ID and (b) a direct-address table (array) indexed by ID.

**H1a. Differences**  
 A balanced BST (e.g., red–black tree) provides O(log n) search/insert/update and maintains sorted order by ID, which could help with ordered reporting but is slower than average-case hashing. A direct-address table provides O(1) worst-case lookups but requires preallocating an array sized to the maximum ID, which is space-inefficient if IDs are sparse (Western Governors University, n.d.).

References

Western Governors University. (n.d.). Sample core algorithm overview [Internal course handout for C950].

Western Governors University. (2025a). Salt Lake City downtown map [Internal project document for WGUPS routing].

Western Governors University. (2025b). NHP3 Task 2: WGUPS routing program implementation (Data Structures and Algorithms II — C950) scenario and requirements [Internal task prompt].

Western Governors University. (2025c). WGUPS package file [Microsoft Excel spreadsheet].

Western Governors University. (2025d). WGUPS distance table [Microsoft Excel spreadsheet].