Finding the Lowest-Cost Route (in terms of fuel expenses) Between Two Cities

First, I reviewed the fuel data file:

- I observed that some records were duplicates, meaning that different records with varying prices were registered for a single fuel station.
- I combined these duplicate records into a single entry and assigned the average of all available prices for that record.
- To find the distance between cities and fuel stations, I needed the geographical coordinates of each city. So, using the documentation on the website https://simplemaps.com/data/us-cities, I added the *latitude* and *longitude* columns to the CSV file.
- Not all columns were necessary for this project, so I created a separate file containing only the *OPIS Truckstop ID*, *latitude*, *longitude*, and *Retail Price* columns. I named this file **cleaned_fuel_data.csv**.

Method Used:

- In *find_all_routes* function by using the free API from http://router.project-osrm.org, I retrieved all possible routes between the two input cities. The routes contain the geographical coordinates of the cities along the way.
- I wrote a function named *find_next_city*. This function, based on the city it receives as input, checks the farthest city that can be reached on a single tank of gas. In other words, it finds the last city that can be reached before running out of fuel (based on a range of 500 miles).
- In the *find_optimal_route* function, it examines all feasible routes between the two cities and also fuel stations to find the cheapest route based on fuel costs. The method is as follows:
    - It starts from the origin city and, using *find_next_city*, finds the next city.
    - In this city, it uses the data read by the *Pandas* library to locate the nearest fuel station using the *Haversine* method.
    - The distance needed to reach the fuel station from the city is added to the distance covered so far. This way, the amount of fuel used by the time the vehicle reaches the fuel station and then the remaining fuel are determined. The vehicle refuels based on the fuel consumed, and the fuel cost is calculated using the *Retail Price* at that location (after refueling, the fuel tank is full).
    - The vehicle must then travel back from the fuel station to the last city before continuing toward the destination. This additional distance is included in the distance to the next city.

- This process continues until reaching the destination. Since it is possible that some fuel remains when reaching the destination (if the distance is less than 500 miles), the remaining fuel from the last fuel station to the destination is calculated. If fuel is left in the tank of the vehicle, the remaining fuel's value is calculated based on the *Retail Price* of the last fuel station and deducted from the total cost. (Because this remaining fuel is essentially an asset that hasn't been consumed yet).

Output:

- The output is a dictionary that includes the lowest-cost route and the associated expense.
- The route information lists the origin city, intermediary cities, fuel station locations, and the destination city.

I've tried to write this program as accurately as possible, but if you notice any issues, I'd appreciate your feedback to enhance my learning and improve my work in the future.

Best regards,

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