INFR 2820U: Algorithms and Data Structures

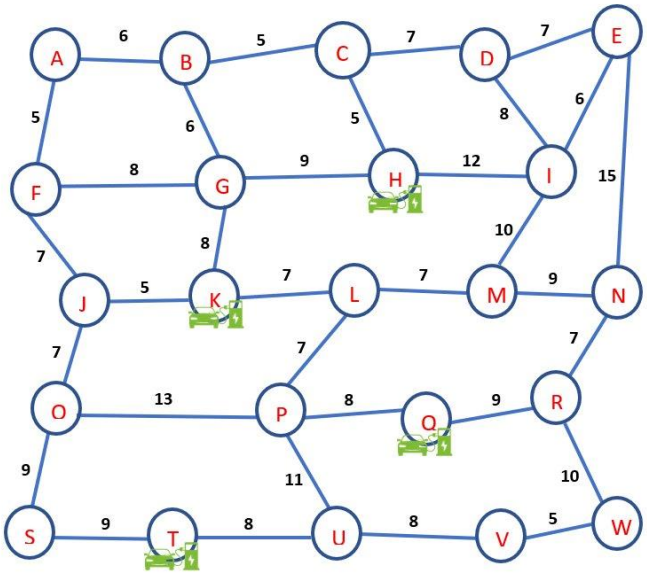
Group Project: EV Charging Station Route Optimization Application

Background:

The transition to Electric Vehicles (EVs) is a critical step towards reducing global carbon emissions. However, the effectiveness of this transition is heavily reliant on the accessibility and efficiency of EV charging infrastructure. This project focuses on leveraging algorithmic solutions to optimize route planning for EV users, making the process of locating and navigating to the nearest or most convenient charging station as seamless as possible.

Project Details:

The goal is to develop an application that, given a starting point in a network of 23 nodes (including 4 charging stations), finds the shortest path to each charging station and recommends the most efficient route based on distance and other relevant factors.



- This image outlines the network of nodes (A to W), including the locations of charging stations (H, K, Q, T) and the distances between nodes.
- Students must accurately translate this information into a structured format, such as a CSV file or an array within the program, to be used for graph construction and route analysis.

Project Group Formation:

- The project must be completed in groups of max four students. Please find your preferred group members and join the project groups created in the canvas.

Topics Covered:

- Graph Theory and Shortest Path Algorithms
- Dynamic Route Optimization
- Data Structures: Graphs, Priority Queues

Learning Outcomes:

- Implement and apply Dijkstra's algorithm for finding the shortest path in a network.
- Understand and analyze the efficiency of routing algorithms in real-world applications.
- Develop practical skills in dynamic data structure manipulation and optimization.

Tasks:

1. **Graph Construction and Data Loading:**
    - Load a predefined network of nodes and edges from an external file (get data from the given image).
    - Construct a graph representing the network, with nodes and weighted edges indicating distances.
2. **Routing Algorithm Implementation:**
    - Implement Dijkstra's algorithm to determine the shortest path from the starting node to each charging station. This will show all the possible shortest paths for all four-charging station from a starting point (E.g., Node A).
3. **Route Recommendation System:**
    - Analyze the computed paths to recommend the most efficient route to a charging station based on total distance.

Deliverables: **(100 Marks)** A report that includes:

1. **Project Report (30 Marks):** Detailed documentation including introduction, methodology, application details with screenshots, and conclusion. Discuss the algorithm's efficiency, real-world applicability, and insights gained.
2. **Code Implementation (40 Marks):** A GitHub repository with the complete, well-documented source code. Include a README with setup and execution instructions. Code quality, documentation, and adherence to best practices will be evaluated.
3. **Presentation (20 Marks):** A 2/3 minutes video presentation detailing the project's objectives, implementation, and a demo. Assess clarity, content organization, and the ability to convey complex information effectively.
4. **Efficiency Analysis (10 Marks):** A technical analysis of the algorithm's performance, including time complexity and space efficiency. Compare with alternative routing algorithms, if applicable.

Submission Guidelines:

- Your report should be concise, well-organized, and clearly written.
- Combine the report, code link, and presentation video into a single submission document. Submit through the canvas before the deadline.

Deadline: March 30, 2024
Note: This is a group project. Plagiarism will not be tolerated.

Contact TA for assistance:

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Step-by-Step Guidelines for Completing Project:

1. Understand Graph Theory and Dijkstra's Algorithm.
2. Load and process the network data from the file.
3. Implement the shortest path finding using Dijkstra's algorithm.
4. Develop the route recommendation logic.
5. Test the application with various starting points.
6. Document the process, findings, and insights in the project report.
7. Record a presentation that demonstrates the application and discusses its significance.

Sample Data from Image:

```
graph = {
    'A' : {'B': 6},
    'B' : {'C': 5},
    'C' : {'D': 7},
    'D' : {'E': 7},
    ……….……
}
```