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Biweekly Update: March 8 - March 21
Project: Federated Learning for Adaptive Road Efficiency (FLARE)

Over the past two weeks, progress was made in several key areas: setting up simulations, analyzing traffic data, and conceptualizing a Federated Learning (FL) network architecture. Despite some challenges with software and data, these efforts have laid a solid foundation for future work, including the integration of SUMO and OMNeT++.

Software Setup and Integration:

- System Setup: Due to simulation issues on macOS, the project was moved to a Windows machine. SUMO and OMNeT++ were successfully installed, allowing for smoother simulation work.

- SUMO Traffic Simulation: Using SUMO's Python tools, a simulation of downtown Victoria was generated from OpenStreetMap (OSM) data. This provided a foundation for mapping and simulating traffic flow in Victoria.

- Data Integration: Traffic data from the City of Victoria Open Data Portal was obtained and overlaid on OSM. The data included 24-hour vehicle counts, but lacked intersection-specific details and directional flow, posing challenges for modeling accurate inflow-outflow systems. Despite this, potential solutions were identified, such as assuming 50/50 splits for directional flows and using GIS tools like QGIS to further process the data.

Federated Learning (FL) Network Design:

- Network Architecture: A hierarchical, partially meshed network topology for FL was conceptualized. Each cluster (A, B, C, D) is fully connected internally, with "a-nodes" serving as gateways linking clusters. The structure allows both local and global communication, simulating decentralized model sharing between peers in a gossip-based FL system.

- Gossip Protocol Development: A gossip protocol for communication was designed, with nodes dynamically adjusting their gossip weights based on traffic volume, redundancy, and network load. This flexible approach will allow nodes to share updates not only within their local cluster but across the entire network, enabling multi-hop communication.

Significant progress was made in setting up the simulation environment, processing traffic data, and conceptualizing the FL network. While there are challenges with the traffic data, solutions are being explored, and the next steps focus on refining the simulation and integrating it with the FL system for more dynamic, real-world modeling.

Next Steps:

- **Traffic Data Processing**: Still need to finalize intersection modeling and handle the incomplete traffic data (directionality, time-of-day variations) before building more precise flow models. (I don't think I'll have the time for this realistically lol)
- **SUMO Integration**: With the downtown Victoria simulation running, next steps involve isolating intersections of interest and determining how to incorporate them into the federated learning network.
- **Gossip Protocol Development**: I'll continue building out the gossip protocol in OMNeT++ as a proof of concept, iterating on node roles and communication strategies, before merging this with the SUMO-driven traffic flow.
- **Architectural Refinement**: Plan to evolve the federated learning architecture, including dynamic roles and gossiping priorities, to better align with the multi-hop communication nature of urban traffic networks.