Tyler Trott V01040680

Biweekly Update: February 22 – March 7

Project: Federated Learning for Adaptive Road Efficiency (FLARE)

Network Architecture Exploration

Over the past two weeks, significant progress has been made in defining the network architecture for traffic intersection management. Initial thoughts revolved around using a Content Addressable Network (CAN) due to its spatial locality and decentralised nature. However, concerns regarding routing performance under real-time conditions led to a pivot towards Kademlia, which offers better lookup features and fault tolerance.

Key Takeaways:

- CANs provide simplicity and stability for fixed-position intersection nodes but may struggle with scalability, especially if expanded to include smart vehicles.
- Kademlia was selected as the preferred approach due to its structured peer-to-peer nature and ability to handle high-frequency updates efficiently.
- Additional research into gossip-based protocols is ongoing, with emphasis on their applicability to federated learning aggregation, review RS4 document for more info.
- Relevant papers on gossip-based peer sampling and aggregate computation have been identified for further study.

Simulation Environment Setup

Efforts have been focused on establishing a simulation framework capable of modeling the proposed architecture. OMNeT++ was selected as the primary simulation tool, and the setup process has been completed successfully. Initial test projects were built, verifying the feasibility of packet-based communication.

Current Progress:

- Successfully installed OMNeT++ and tested basic simulations.
- Identified OverSim as a suitable framework for integrating Kademlia-based network simulations.
- Imported OpenStreetMap (OSM) data into OMNeT++ for city and traffic layout simulation of downtown Victoria.
- Developed a basic traffic flow model, including vehicle movement along predefined routes.
- Investigating methods to implement intersection control and dynamic vehicle stopping at traffic lights.

Traffic Light Control and Integration

The next major milestone involves integrating traffic light control logic within the simulation. The goal is to develop a dedicated traffic light controller module using a state machine to cycle through light phases.

Challenges and Progress:

- Exploring methods to dynamically modify light phase durations based on learning algorithms.
- Investigating the use of SUMO (Simulation of Urban Mobility) and its integration with OMNeT++ via TraCI.
- Encountered issues with SUMO dependencies; current workaround involves cloning and building from the GitHub repository.
- Evaluating Veins, an open-source vehicular network simulation framework, for potential integration.
- Considering TraCI as a Service (TraaS) as an alternative for easier communication with SUMO.

Next Steps

- Finalize the integration of SUMO into the project.
- Define the traffic light control logic and implement it in the simulation.
- Establish a network topology with communication protocols (Kademlia/gossip-based models).
- Develop a structured approach to federated learning aggregation (if aggregation at all) in the system.
- Conduct parameter tuning for message frequency, node latency, and learning update intervals.
- Continue testing and iterative development to refine the overall model.

Despite some challenges, substantial progress has been made in both network architecture and simulation setup. The focus remains on overcoming integration hurdles and refining the adaptive traffic control model. Looking ahead, the next steps will solidify FLARE’s foundation, paving the way for a comprehensive, data-driven traffic management system.