Release No. 13
Mexico City, march 22nd, 2026

IPN Develops Traffic Simulation System Using Algorithms and Historical Data

- **Developed at the Escuela Superior de Cómputo (ESCOM), the FLUVI system replicates traffic behavior through mathematical models to assess the impact of road modifications**
- **Its adaptable architecture allows application across different urban settings, establishing a methodological benchmark for traffic flow optimization research**

To better understand the traffic congestion faced by large cities—often caused by factors such as fallen trees, flooding, roadworks, or public demonstrations—students from the Instituto Politécnico Nacional (IPN) have developed a traffic flow simulator that uses algorithms based on historical data and mathematical models to predict vehicle behavior across different road networks.

The FLUVI simulator, created by ESCOM students Denisse Márquez Morales, Luis Gael Molina Figueroa, and Connor Urbano Mendoza, is designed to replicate the evolution of traffic systems over time. It relies on one or more mathematical models that define vehicle movement and interactions within complex environments.

The project aligns with the national vision for technological sovereignty and innovation promoted by Claudia Sheinbaum Pardo, President of Mexico, in coordination with the policies led by Mario Delgado Carrillo, Secretary of Public Education.

Developed at the Artificial Life Laboratory (Alirob), the study focused on traffic flow within the "Adolfo López Mateos" Professional Unit in Zacatenco, as well as surrounding streets and avenues, using a mathematical framework known as a complex system.

"Traffic simulation is inherently a complex system, involving interactions among vehicles within their environment, individual and collective decision-making, traffic flow management, and real-time visualization of urban scenarios," explained Luis Gael Molina.

With guidance from professors Genaro Juárez Martínez and Idalia Maldonado Castillo, the team implemented algebraic structures known as cellular automata to efficiently model vehicular behavior, allowing vehicles to move autonomously according to algorithmic rules.

According to the developers—who created the system as part of their Computer Systems Engineering degree—the model can simulate multi-lane traffic, lane changes, congestion formation and dissipation, intersection dynamics, and interactions among vehicles traveling at different speeds.

"The FLUVI simulator was built using 42 modules in JavaScript, along with HTML, CSS, and Python files. It integrates a cellular automata-based simulation engine with modules for traffic, graphs, scenarios, time, curves, parking, and centralized event management with probabilistic entry and exit rates by hour," detailed Denisse Márquez.

The system enables the creation of customized scenarios, the generation of statistical metrics in virtual time—such as flow, density, speed, and entropy—and the evaluation of road modifications without requiring physical implementation.

Although FLUVI was initially designed for the internal circuit of the Zacatenco campus, its creators emphasize that its modular architecture and cellular automata-based methodology make it adaptable to a wide range of urban configurations. As such, it establishes a methodological precedent for future research in traffic modeling and optimization, supporting more informed decision-making in mobility, safety, and urban planning.

For more information, visit www.ipn.mx

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