

IE630 Project Assignment 1

Problem Definition & System Overview

This project simulates vehicle and pedestrian movement through a busy intersection. It focuses on the impact of various traffic control strategies—including traditional fixed signals, synchronized (green-wave) signals, roundabouts, and adaptive smart systems—on both vehicular and pedestrian flows. The simulation uses AnyLogic software to model:

- **Vehicle Movements:** How vehicles enter, traverse, and exit the intersection under different signal timings.
- **Pedestrian Movements:** How pedestrians cross the intersection, governed by pedestrian traffic light controls integrated with vehicle signals.

The overall goal is to evaluate the combined impact on traffic flow, pedestrian safety, and environmental factors, capturing metrics such as vehicle delay, pedestrian waiting time, and congestion levels.

Structured System Representation (Diagrams or Process Flows)

Process Flow:

1. Input Data & Parameter Setup:

- **Vehicles:** Define arrival rates, vehicle characteristics, and route choices.
- **Pedestrians:** Define arrival rates, walking speeds, and crosswalk locations.
- **Control Strategies:** Set up signal timings for vehicles and pedestrians, including coordination rules (e.g., all-red phases for safety, pedestrian countdown timers).

2. Simulation Execution:

- Vehicles and pedestrians are generated based on defined arrival distributions.

- The control system manages vehicle movements and pedestrian crossings through coordinated traffic and pedestrian signals.
- Both vehicles and pedestrians interact within the simulation environment, observing safety protocols and waiting for the appropriate signal phase.

3. **Data Collection & Analysis:**

- **Vehicles:** Track delay times, queue lengths, and noise level
- **Pedestrians:** Monitor waiting times, crossing delays, and safety incidents.
- Comparative analyses are performed across different control strategies to assess overall intersection performance.



Assumptions, Data Sources, and Constraints

- **Assumptions:**

- **Vehicle Behavior:** Vehicles follow set acceleration/deceleration patterns and adhere to traffic rules.
- **Pedestrian Behavior:** Pedestrians maintain constant walking speeds, obey traffic signals, and exhibit typical reaction times.
- **Traffic Demand:** Both vehicular and pedestrian arrival rates are modeled based on predefined distributions reflecting peak and off-peak conditions.
- **Intersection Layout:** The intersection design is simplified yet represents key real-world characteristics for both vehicle and pedestrian flows.

- **Data Sources:**

- **Empirical Traffic & Pedestrian Data:** Local transportation department data on vehicle counts, pedestrian crossing volumes, and intersection geometry.
- **Research Literature:** Studies and benchmarks on mixed-mode traffic simulation, pedestrian safety, and signal coordination.
- **Calibration Data:** Historical simulation data and real-world observations used to fine-tune model parameters for both vehicles and pedestrians.

- **Constraints:**

- **Computational Resources:** Simulation complexity and run-time are limited by available computing power.
 - **Simplified Dynamics:** Certain factors—such as the impact of weather conditions or unexpected pedestrian behaviors—may be abstracted.
 - **Integration Complexity:** Coordinating simultaneous vehicle and pedestrian signals can add complexity, and scaling to a network of intersections requires additional considerations.
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Objectives & Performance Metrics

- **Objectives:**

- **Evaluate Traffic & Pedestrian Management Strategies:** Compare various control systems (traditional fixed, synchronized, roundabout, smart adaptive) to determine their effectiveness in managing both vehicular and pedestrian flows.
- **Optimize Intersection Performance:** Identify optimal configurations that minimize delays, reduce congestion, and enhance pedestrian safety.
- **Assess Environmental Impact:** Evaluate the influence of traffic control strategies on fuel consumption and emissions, considering both vehicle stop-start cycles and pedestrian interactions.

- **Performance Metrics:**

- **Vehicle Delay:** Average time vehicles wait at the intersection.
- **Pedestrian Waiting Time:** Average time pedestrians wait at crosswalks before being allowed to cross.
- **Congestion Levels:** Measured through vehicle queue lengths and intersection occupancy.
- **Noise Levels :** Noise of honking due to traffic jams and congestion of vehicles and pedestrians on the road.
- **Safety Indicators:** Frequency of conflicts or near-miss incidents between vehicles and pedestrians, providing insight into the overall safety of the intersection.