TraSMAPy ITS API - Project Specification

Group members

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Project Introduction

Intelligent transportation systems (ITS) has been a domain with progressively more relevance when tackling problems related to the growing urban traffic volume in modern cities. Simulations are a valuable tool to explore hypothesis and make decisions about strategies to tackle these problems: traffic congestion, lack of parking spots, etc...

Although simulations are valuable, there is a barrier of entry to people without an informatics background, e.g., traffic-engineers. As such, there is space in the market for the development of utilities that **abstract** *low-level* simulation concepts into *higher-level* real-life concepts.

The objective of this project is to create a ITS-related meta-model, supported by an API that makes it easier for researchers to instantiate it in multiple scenarios. This API should streamline the process of creating simulations of transport systems in SUMO traffic simulator.

To demonstrate the usage of the API, we will model and simulate a simple scenario comparing policies to alleviate traffic congestion involving individual/private vehicles and collective/public transport.

API concepts

Each API concept belongs to one of three categories: user, infrastructure and regulator.

User

Vehicles (+ occupation)

- Private vehicles (single or multiple occupants)
- Public transport
- Emergency vehicle

Vehicle fuel consumption/CO2 emissions

- Eletric
- Traditional combustion

Driver

- Human driver
- (Connected) autonomous vehicle

Infrastructure

- Road types (low capacity road/highway)
- Intersection/Junction
- Traffic light (simple or with communication mechanisms)
- Parking lots

Regulator

- Road pricing schemes
- Zones with regulated/restricted access
- Ramp metered junction
- Regulated parking lots (booking / auction / reserved spaces)

Metrics

- Throughput at junction
- Traffic congestion
  - Time stopped / Number of vehicles
- Number of vehicles
- Number of passengers (people per car)
- CO2 emissions
- Avg. vehicle tool:
  - Based on road pricing schemes
- Road usage
  - Based on road capacity
- Parking lot lotation
  - Including umber of vehicles without parking available

Example usage

Which topics to use for the following scenario:

> Comparisons between individual (private vehicle) and collective (public transport) policies to alleviate traffic congestion.

1. Predictive and speculative simulation
2. Exogenous variables of the model:
   - Controllable: number vehicles, number of passengers, road lane policy (public transportation-exclusive lanes)
   - Uncontrollable: road speed limits, number of lanes
3. Endogenous variables of the model:
   - Passenger throughtput
   - Time stopped
   - Traffic density/congestion
   - Total vehicle emissions
   - Money spent on road pricing scheme
   - Average vehicle speed
4. Performance metrics:
   - Passenger throughtput
   - Time stopped
   - Average time to reach destination (for private and public transport)
   - Money spent on road pricing scheme
   - Total vehicle emissions
5. Key performance indicators (KPI):
   - Traffic density/congestion
   - Cost per passenger (related to road pricing scheme)
   - Difference between the private and public transportation time taken to reach destination
   - Emission in relation to cost for each passenger
   - Time(%) under the road lower speed limit (due to traffic congestion)
6. Operational policies:
   - Road lane with exclusive access for public transport
   - Road lanes with extra costs for private vehicles

    - Penalise private vehicles that transport few passengers/aren't full
7. Possible data collection methods, techniques and tools:
    - No data collection
    - Possibly collect map information for OSM (Open Street Map)
8. Models validation:
    - Not possible without access to real world past data.
9. Possible scenarios to be simulated:
    - Simple road with 2 lanes in each direction (only private transportation)
    - Similar scenarios but considering public transportation (25%, 50%, 75%, and 100% of the passengers)
    - Repeat previous scenarios but with additional roads and intersections
    - Highway-like scenario where there is an "external" influx and efflux of vehicles
    - Limiting the use of the right-most lane exclusively to public transportation
10. What operational decisions could be supported by the simulation models?
    - Find new road policies/pricing schemes to reduce traffic congestion and emissions
    - The increase or decrease in the number of lanes of certain roads

API Concepts

- User:
    - Private vehicle
    - Public transport
- Regulator:
    - Road pricing schemes
    - Zones with regulated/restricted access
    - Metrics:
        * Throughput at junction
        * Traffic congestion
        * Number of passenger

Coding

The API will be based on the structure and ideas of the TraSMAPI framework and implemented in python to lower the barrier of entry. We're only targeting SUMO traffic simulator, so the API will interact with it through the TraCI API.

Tools

- Python
- SUMO (Simulation of Urban MObility)
- TraCI