SPILab by QuercusSEC

UNIVERSIDAD DE EXTREMADURA

QUERCUS

SmartTLC: Towards Smart Traffic Light Systems

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Problem statement

2 Million Children May Suffer From Asthma Every Year Due To Traffic Pollution: Study

Source: News 18

EU looks to data and technology to reduce transport emissions

Source: Pinsent Masons

Experts say reduced traffic volumes amid Covid-19 have had a positive impact on air quality

Source: IOL

Majority support tighter EU car emissions rules and are willing to pay

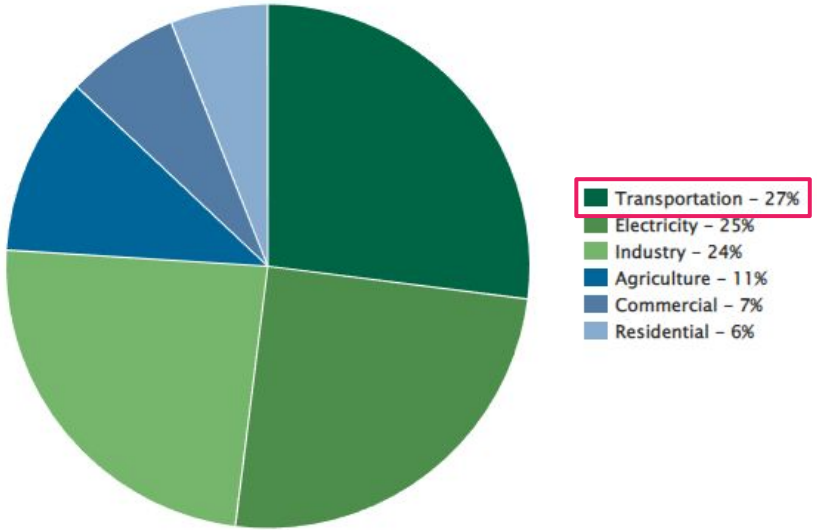
Source: Transport & Environment

Intelligent Transportation Systems Market size worth $ 96.68 Billion, Globally, by 2030 at 6.7% CAGR: Verified Market Research®

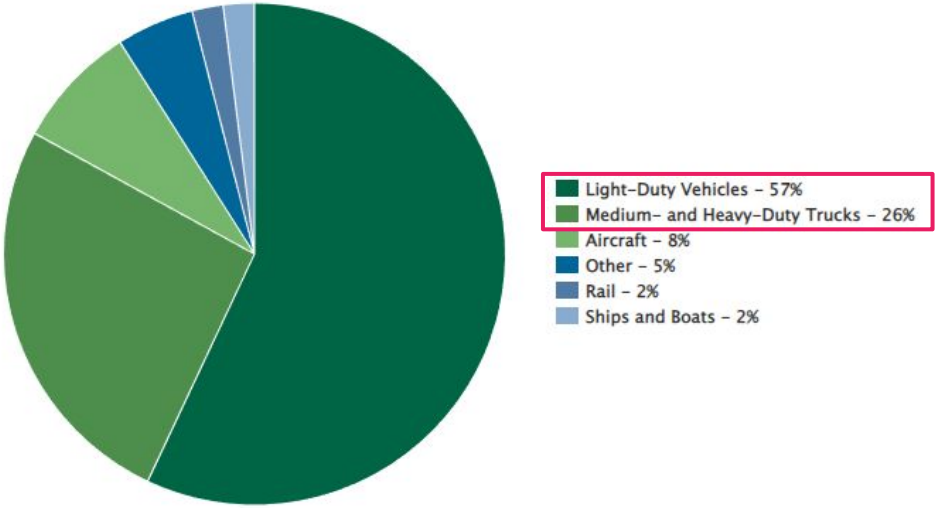
Source: PR Newswire

Problem statement

2020 U.S. GHG Emissions by Sector



2020 U.S. Transportation Sector GHG Emissions by Sector



Source: United States EPA

Our solution

Identify traffic flow patterns

Analyze traffic light control algorithms

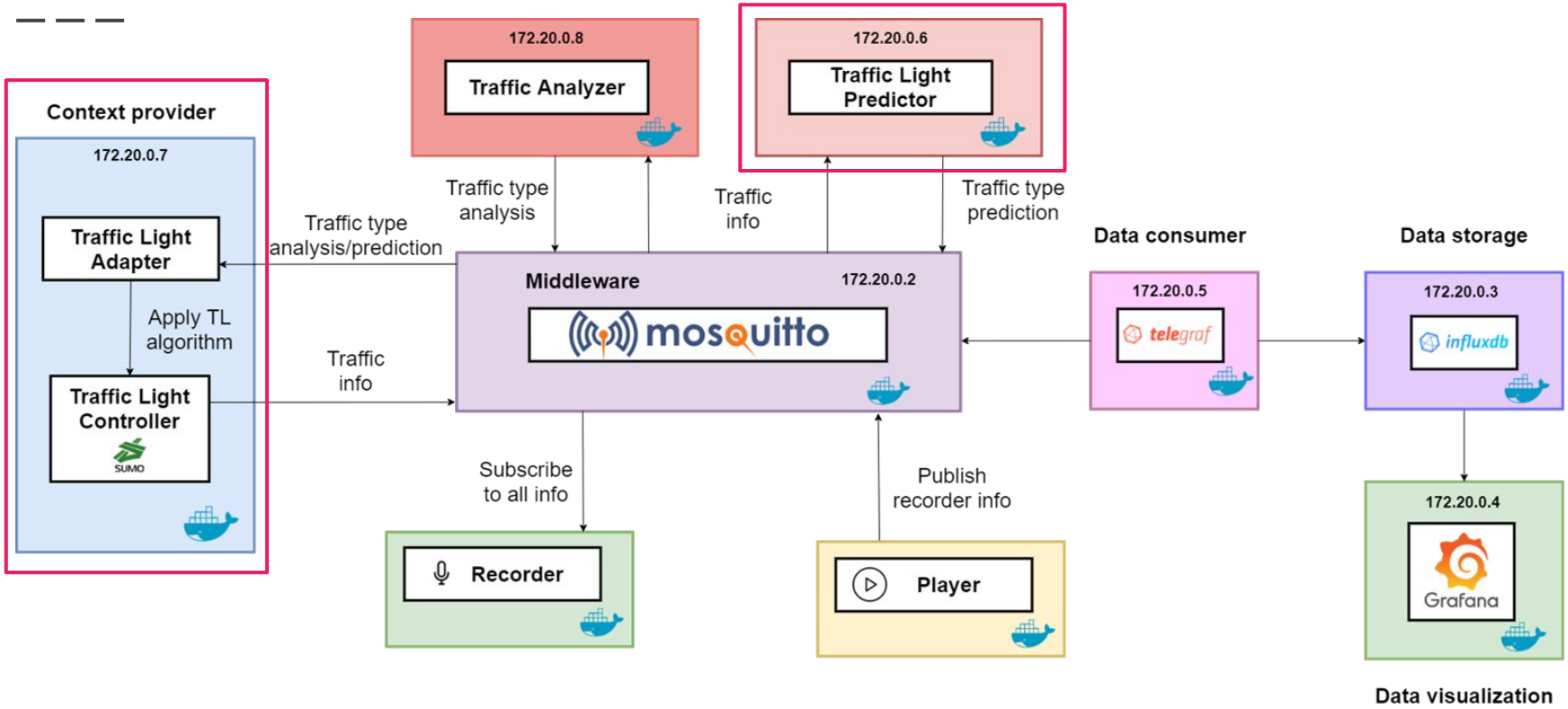
Develop a framework to compare traffic light adaptation approaches in terms of vehicle waiting time

Predict traffic flow patterns based on historical data

Detect current traffic flows based on real-time contextual data

Analyze and compare simulation results with different adaptation approaches

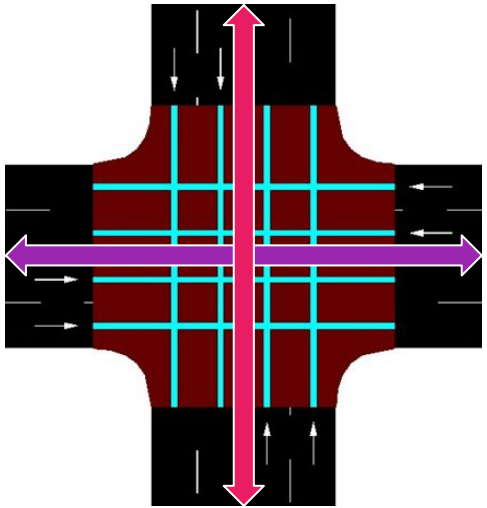
SmartTLC architecture



Scenario

NS direction

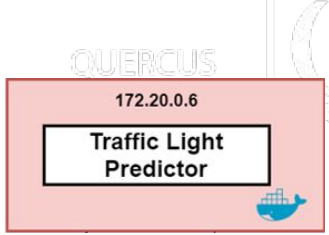
EW direction



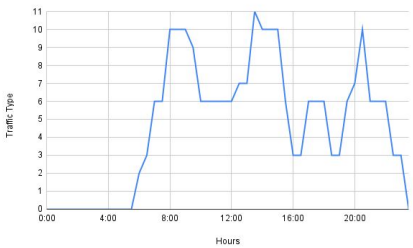
Type	Vehicles per hour	Range
Very Low	3	±2
Low	20	±6
Medium	150	±45
High	500	±150

Combination = 12 traffic flows

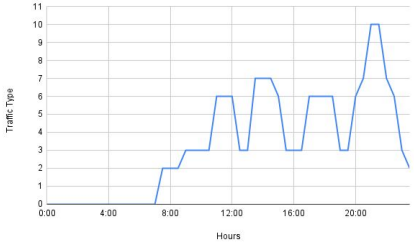
Learning traffic patterns



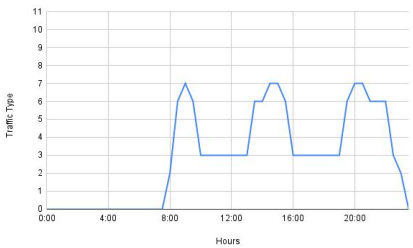
Simulation based on self-defined traffic time patterns



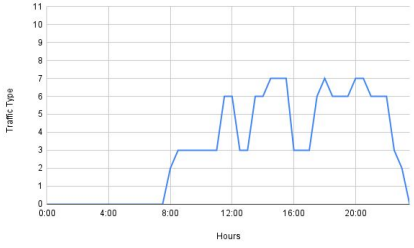
Working day



Saturday



Summer vacation day



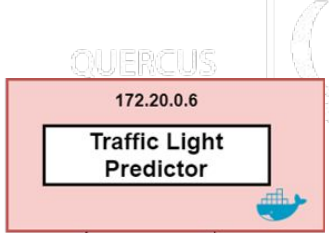
Winter vacation day

✚ Noise policy

- Time pattern swapping
- Traffic type modification

1 year traffic dataset generation

Learning traffic patterns



Supervised learning

traffic_type	passing_veh_n_s	passing_veh_e_w	hour	date_day	date_month	date_year
4	60	30	10:00	1	1	2021

target

date-based

traffic-based

Algorithms used

✚ hyperparameter tuning

- Naive Gaussian Bayes
- Support Vector Machines
  - Linear
  - Polynomial
- K-Nearest Neighbors
- Decision Trees
- Random Forest

Results

Training process

Average

Model	Date-based		Date+Traffic-based	
	Elapsed time	F1 score	Elapsed time	F1 score
Naïve bayes	0.030150	0.143621	0.007067	0.997105
SVM linear	8.087447	0.148330	0.062826	0.999649
SVM polynomial 2	9.386143	0.059206	4.466585	0.630051
KNN	0.302031	0.296457	0.313135	0.999621
Decision Tree	0.011950	0.488837	0.009619	0.887136
Random Forest	0.048436	0.216213	0.042495	0.618791

204 models

Best date-based
Decision Tree (16 depth)
F1 score = 0.692461

Best context-based
Decision Tree (6 depth)
F1 score = 0.999881

KNN = F1 score but higher elapsed time

Results

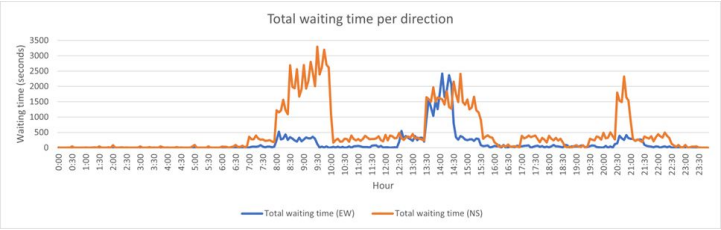
Traffic light adaptation process

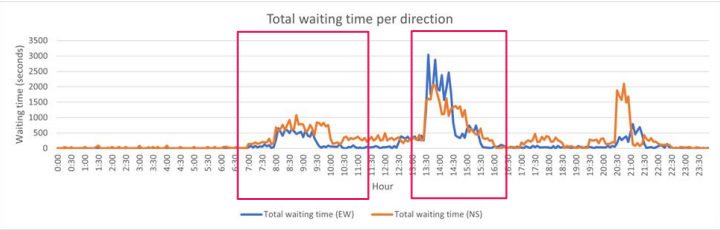
Four adaptation approaches

No adaptation

Using working day pattern

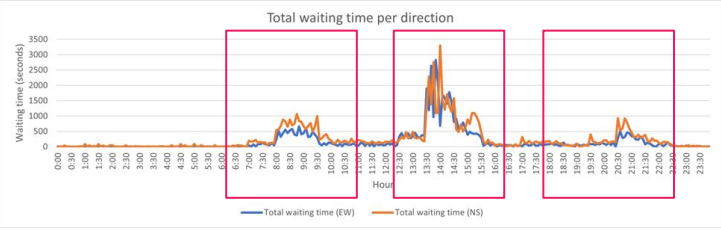
Only predictions based on date

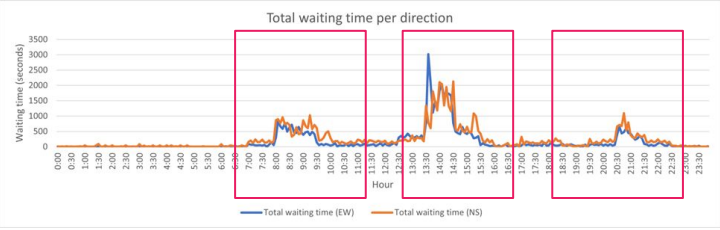




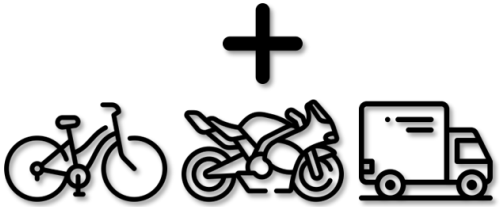
Only real-time analyzer

Both analyzer and contextual predictor

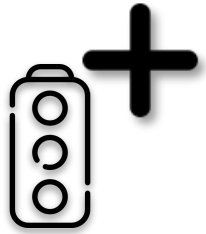


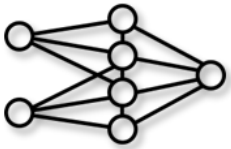


Future works

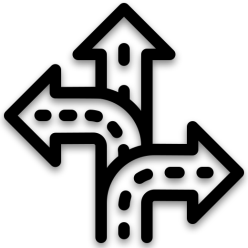


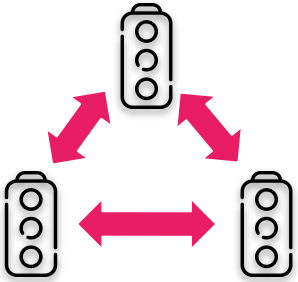
Special adaptation





Traffic type





Thank you!

Any question?