Multicriteria traffic light control focused on optimization goals efficiency, emissions and cyclist safety - a SUMO simulation study

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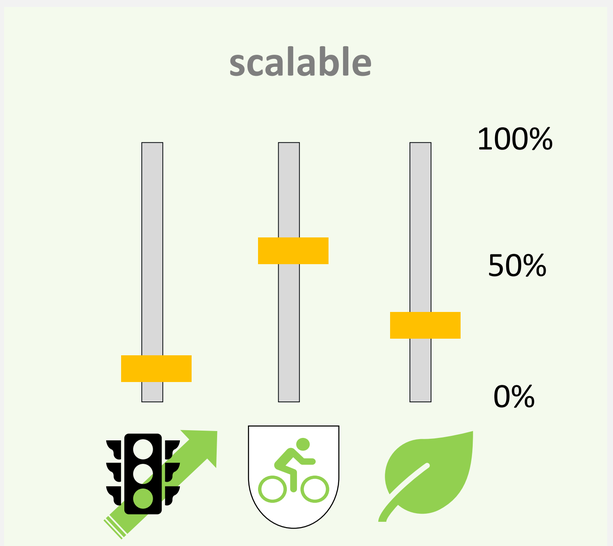
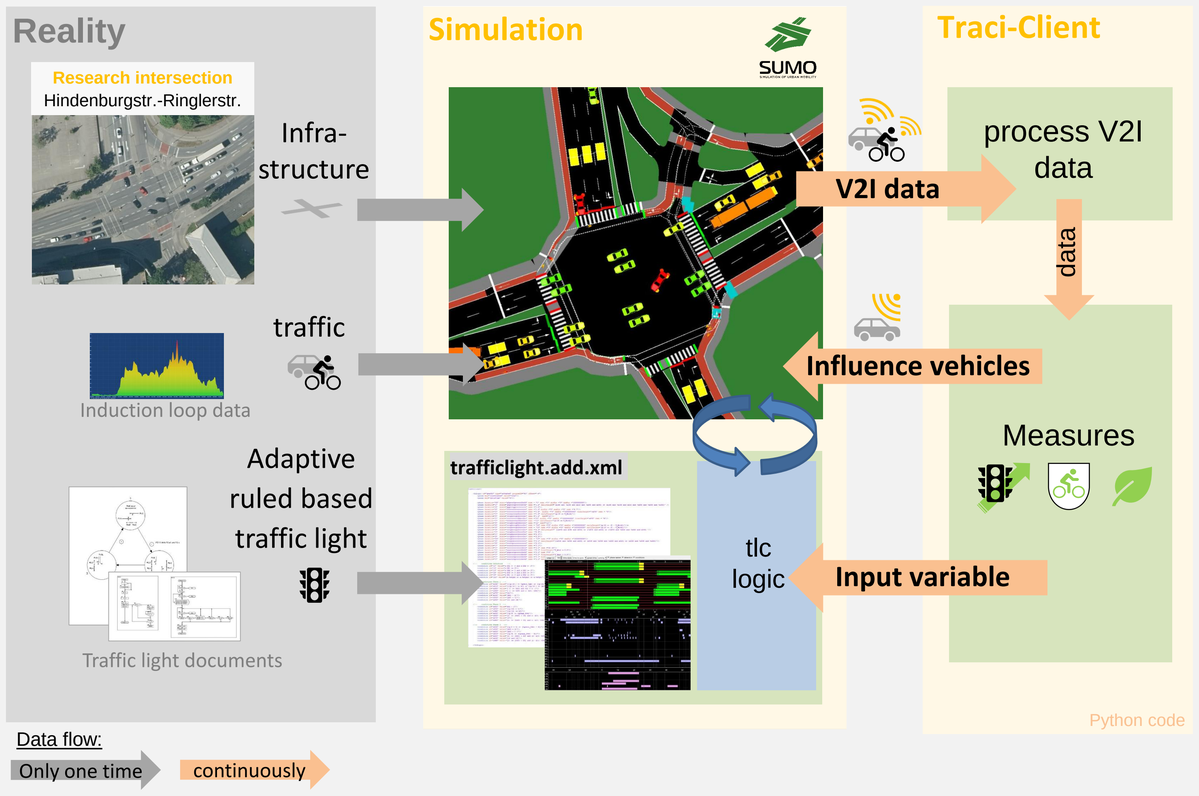
Objective

The multicriteria traffic light control (MTLC) is a rule-based control and offers measures focused on three different optimization goals: Efficiency, emissions and cyclist safety. The different measures can be scaled or switched on and off depending on the current traffic conditions or the optimization goals a city administration might pursue at a specific period of time.



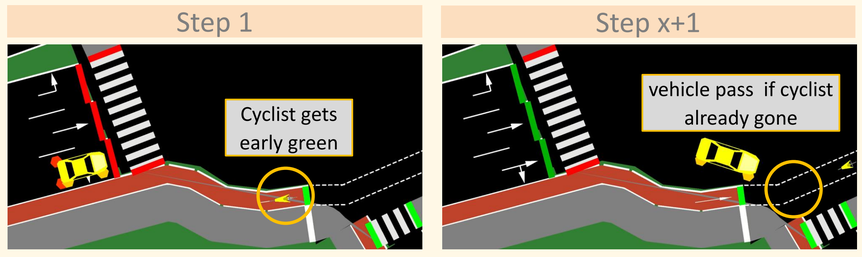
Simulation Setup

The measures are developed and tested in a sumo simulation. For this purpose, a real-world junction and its rule-based traffic light control are rebuilt in a SUMO simulation. The basis for the development of the MTLC is this replicated traffic light control which is then modified with the new control measures. The standard and the modified traffic light control are compared for performance in the same traffic situations with the help of SUMO.



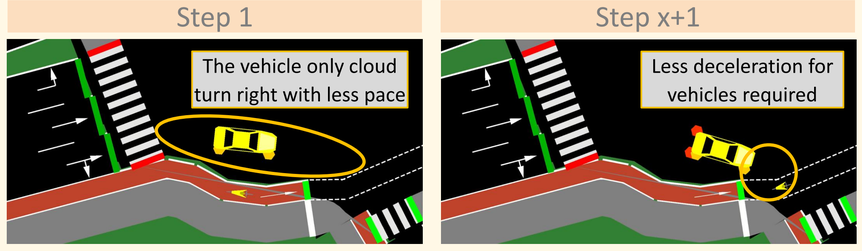
MTLC-Measures

Preponing green time



A present cyclist gets earlier green time opposite right turning vehicles.

Safety slow down



MTLC change vehicles' allowed speed during right turning if a cyclist is present.

Key performance indicators

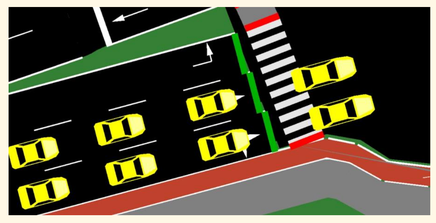
The chosen measures are analyzed in regards to their influence on the optimization goals of the MTLC. The key performance indicators (KPIs) for the optimization goals are overall CO_2 emissions for the emissions category, overall travel time/duration at the junction for traffic efficiency and the number of critical post encroachment time (PET) encounters of the cyclists for cyclist safety.

Efficiency
Travel time in seconds

Safety
Post-Encroachment Time

Emissions
CO_2 - emission in mg

Max acceleration and Max speed



Changing vehicles' allowed speed and maximum acceleration in certain areas of the intersection.

Results

An initial evaluation of the measures' impact in preliminary simulations shows potential to improve the cyclist safety by reducing dangerous encounters. Simultaneously all measures decrease the efficiency of the vehicles whilst not impairing the emissions at the intersection significantly. The table shows the measures deviation [%] of the key performance indicators to the existing standard traffic light control.

deviation									
-60%	-50%	-40%	-30%	-20%	-10%	0%	5%	10%	15%

Measures	Value	Safety	Efficiency			Emissions
		cyclist	cyclist	right turning vehicles	all vehicles	intersection
Preponing green time (P)	4s	-42,9%	0,2%	2,1%	0,9%	0,0%
Safety slow down (SW)	4,5m/s	-27,8%	0,0%	2,7%	0,4%	0,0%
Safety slow down	3,5m/s	-44,6%	0,4%	4,4%	0,4%	0,0%
Max acceleration (MA)	1,75m/s²	-30,1%	0,2%	1,3%	1,7%	0,0%
Max acceleration	0,5m/s²	-62,9%	0,0%	11,9%	13,9%	-0,1%
Max speed	8,3m/s	-9,1%	0,2%	13,9%	14,5%	-0,1%
MA + SW	1,75m/s² + 3,5m/s	-48,4%	0,2%	5,6%	2,3%	0,0%
MA + P	1,75m/s² + 4s	-47,5%	0,2%	3,9%	3,0%	0,0%
SW + P	3,5m + 4s	-58,5%	0,0%	6,5%	1,7%	0,0%
MA + P + SW	1,75m/s² + 4s + 3,5m/s	-54,6%	0,0%	7,5%	3,4%	0,0%

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