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Simulating a Three-Lane Roundabout Using SUMO

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Agenda

> Introduction
> Problem and goals
> Literature review
> Methodological Approach
> Implementation
> Results
> Conclusions and future work

How to tackle the traffic congestion problems?

- By implementing physical modifications to infrastructure
  - Highly expensive, disruptive, and dependent on political decisions
- By improving control and management systems
  - Good results, but not a lasting solution
- By influencing driver/traveller behaviour
  - Extremely difficult!

Problems

> High traffic on roundabouts

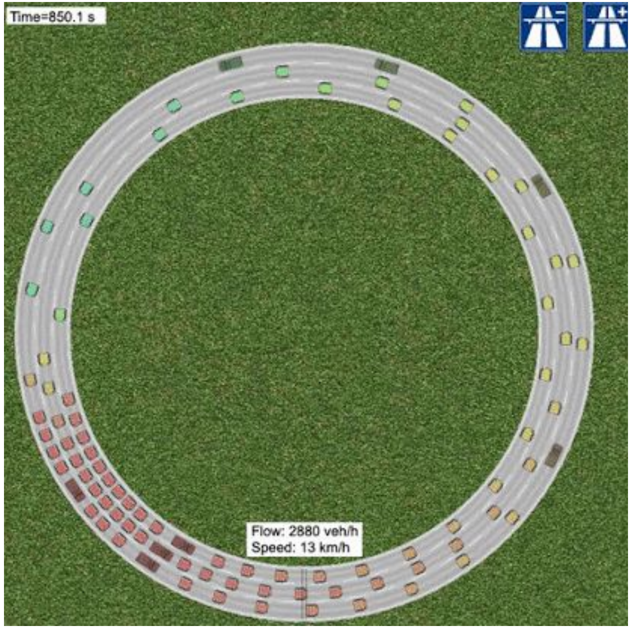
> Agressive driver behaviour

> Creation of shockwaves

> Others that we won't tackle:

> > High number of vehicles

> > Inadequate infrastructures



Goals

> Tackle traffic congestion problems on roundabouts assessing through a computer simulation

> Understand how driver behaviour impacts roundabouts flow

> Minimize shockwaves while improving throughput inside the roundabout

Related Work - Gap Analysis

Authors/ Features	Roundabout types	Roundabout inherent problems	Gap Acceptance	Headway distribution models	Estimation of critical headways	Driver's behaviour	Data Collection	SUMO
K. Shaaban and H. Hamad	x		x	x		x	x	
Ruijun Guo, Leilei Liu and Wanxiang Wang			x	x	x	x	x	
Ruili Wang and Heather Ruskin	x	x	x			x	x	
A.Silva and L. Vasconcelos	x	x		x	x			
R. Ziolkowski						x		
K. Al-Saleha and S. Bendakb	x					x	x	
Catur Yudo Leksono and Tina Andriyana	x						x	x
Our work	x	x	x		x	x		x

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Methodological Approach

- Choosing a three-lane roundabout
- Data collection
- Experimental Setup
- Calibrate the system to simulate the reality
- Result analysis

Choosing a Reference Roundabout

We decided to choose a roundabout that we know well. This one is located in Ermesinde, Valongo, Porto, Portugal next to the Santa Rita church.

Santa Rita Roundabout (41.205901, -8.540968)

Data Collection

To collect **peak hours** for the roundabout saturation we decided to use **traffic information** made available by Google Maps. Through this information we know the most critical times for congestion. Based on the **color scale** defined on this image we can conclude that the critical moments (orange color) are at the end of the afternoon as predicted based on our experience and knowledge of this place.

Santa Rita Roundabout (41.205901, -8.540968)

Critical times for congestion (color scale)

Data Collection

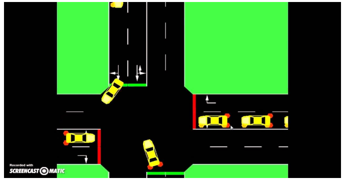
To collect reference speeds of our roundabout we have used data collected by several authors in several papers. We conclude that the values are consistent and they were in agreement with the real data. Below you can see some of these values. ML3 is very similar to our roundabout.

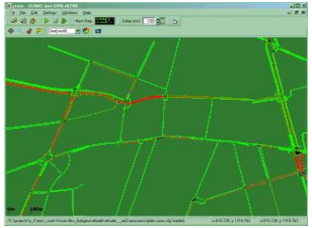
ID	Entry Speed (km/h)	Exit Speed (km/h)	Circulating Speed (km/h)	Circulating Width (m)	Entry Traffic* (vph)
TR1	18.8	21.5	15.8	6.0	275
TR2	21.8	21.7	17.0	6.2	500
TR3	27.5	25.7	26.5	6.1	435
ML1	34.1	40.2	30.1	8.3	585
ML2	32.2	34.2	24.1	8.2	660
ML3	24.0	35.0	26.1	8.1	470

source: EMPIRICAL ASSESSMENT OF TURBO ROUNDABOUT OPERATIONS ON 1 TRAFFIC AND EMISSIONS

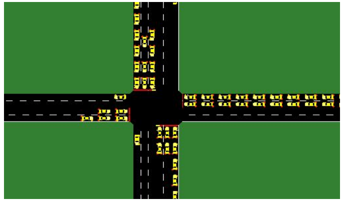
Using *SUMO (Simulation of Urban MObility)*

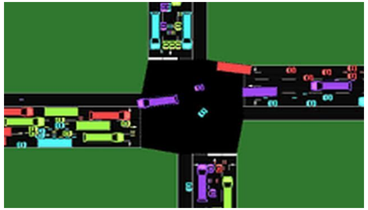
"SUMO is an open source, highly portable, microscopic and continuous traffic simulation package designed to handle large road networks. It is mainly developed by employees of the Institute of Transportation Systems at the German Aerospace Center."





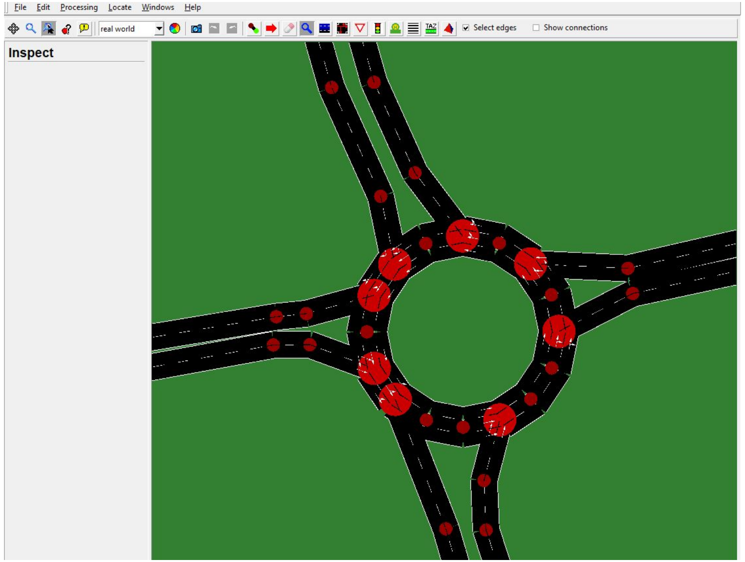
SUMO
SIMULATION OF URBAN MOBILITY



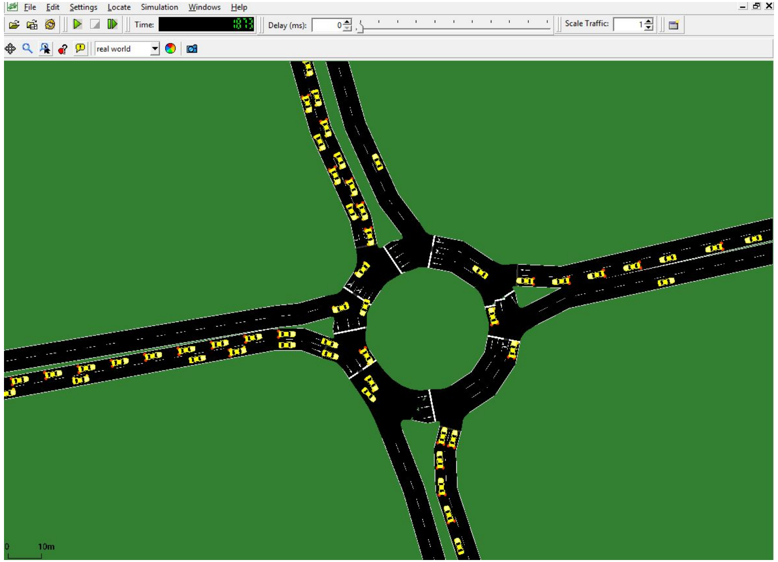


Implementation

Using *NetEdit* and *SumoGui*



NETEDIT final roundabout after subtle changes to match the realone



SUMOGUI Roundabout Experiment, state of Saturation

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Model calibration

> Geometry (lanes, junction points, edges) - *NETEDIT*

> Maximum speeds imposed by lanes - *NETEDIT* and/or *XML*

> Number and type of trips

> Time of simulation

> Traffic rules

> Krauss-Following-Model (velocity, acceleration, minGap)

Our Experiments

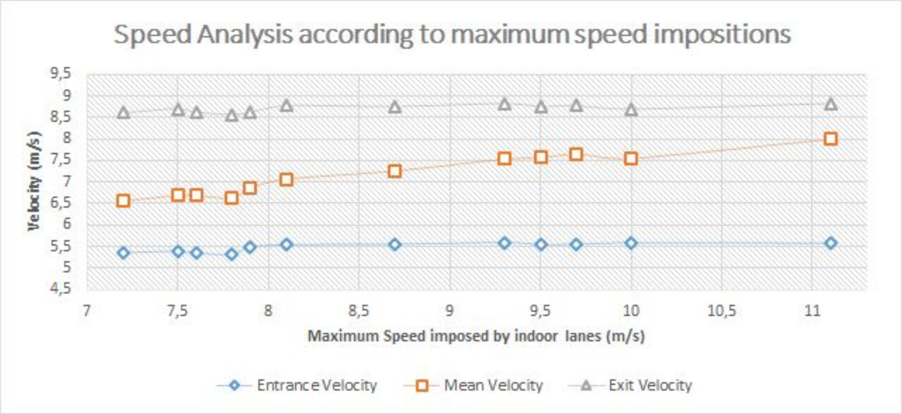
For our simulation plan we have perform around 10-12 runs per experiment. Each run lasts 2000ms and is repeated if any of its output values is biased or unrealistic.

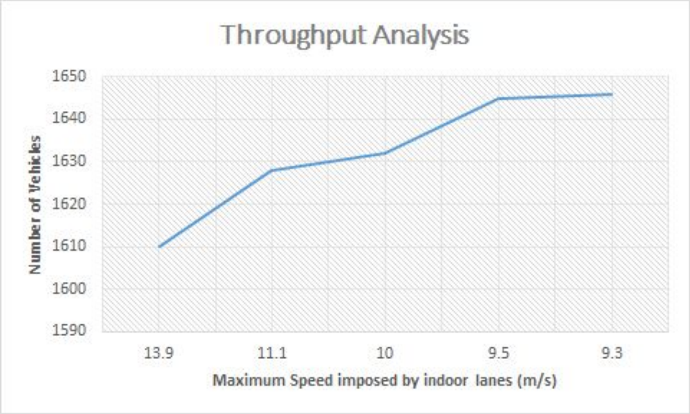
> Exp 1 - Speed Analysis according to **maximum speed impositions** in the **two innermost lanes**

> Exp 2 - Behaviour study of the Krauss Following-Model by **varying minGap parameter**

> Exp 3 - Behaviour study of the Krauss Model by **varying acceleration and minGap parameters**

Results Exp1 - Speed Analysis according to maximum speed impositions in the two innermost lanes

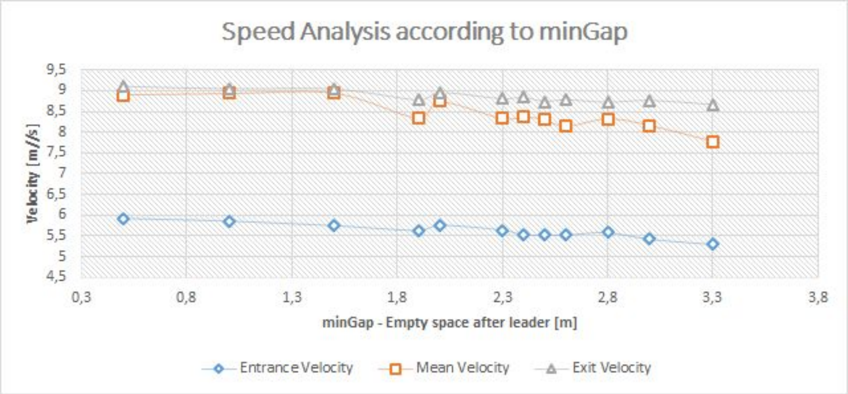


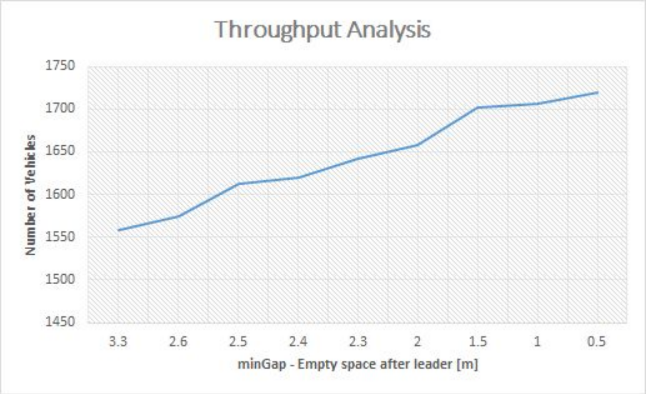


> Imposing maximum speed within the roundabout **decreases congestion.**

> Imposing maximum speed within the roundabout **increases throughput.**

Results Exp2 - Behaviour study of the Krauss Following-Model by varying minGap parameter





> When **decreasing minGap** between vehicles it **increases throughput**. But… When decreasing minGap between vehicles it increases congestion.

> Average circulation velocity **very close** to exit velocity.

Results Exp3 - Behaviour study of the Krauss Model by varying acceleration and minGap parameters

This table corresponds to the throughput according to acceleration and minGap parameters.

minGap/accel	2.4	2.6	2.9	3.2
3.3	1545	1558	1596	1643
2.8	1603	1628	1684	1681
2.4	1614	1620	1677	1688

This table corresponds to the recorded average times [s] of circulation according to acceleration and minGap parameters.

minGap/accel	2.4	2.6	2.9	3.2
3.3	15.08	16.14	13.80	11.97
2.8	14.32	12.94	11.84	11.11
2.4	13.13	13.18	13.61	11.23

> When **decreasing minGap** and **increasing acceleration** it increases **throughput.**

> **But**… When decreasing minGap between vehicles it **increases congestion** and increasing acceleration **creates safety problems.**

Conclusions and future work

> By imposing a maximum speed reduction on the two innermost routes within the roundabout we improve throughput.

> Reduce the minimum safety distance improves flow to a certain extent. The same is applied to acceleration.

> Implementation of speed bumps and a more rugged pavement

> Future research:

- Study the imperfection factor of driver
- Enrich the behaviour of vehicles using the agent-based models through the combination of SUMO and TraSMAPI
- Improve our conclusion by use this model in other three-lane roundabouts.

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Thank you!