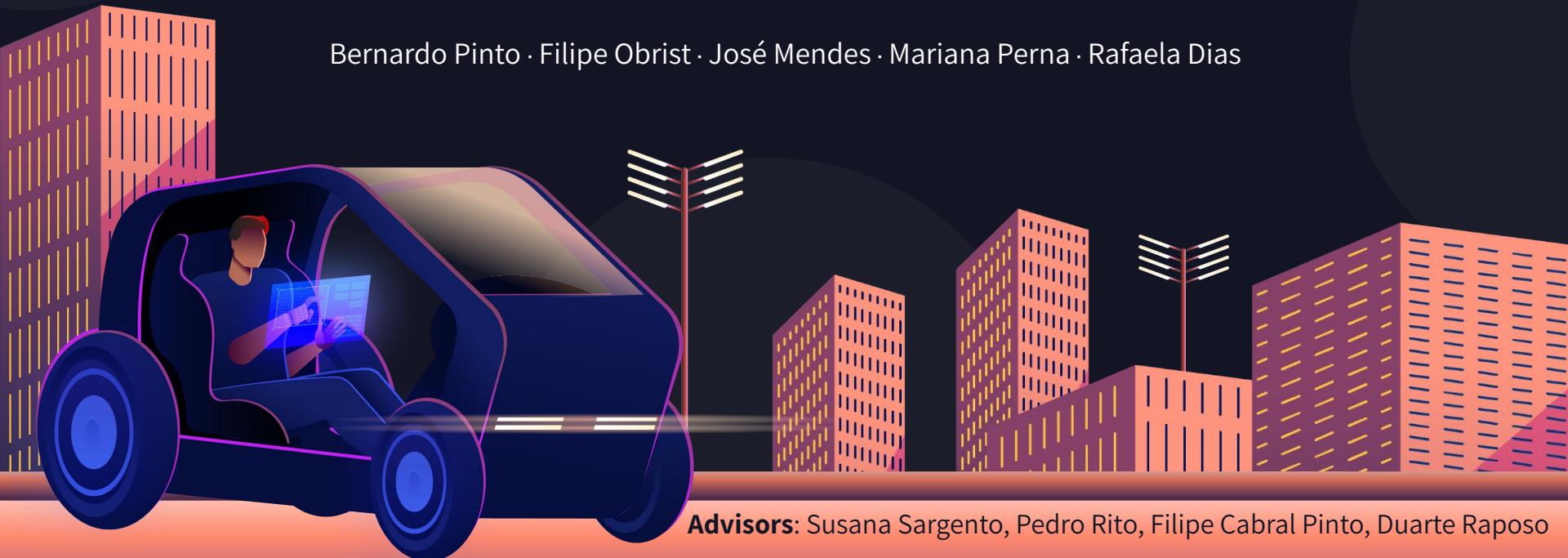


# AVEIRO TECH CITY LIVING LAB

## DIGITAL TWIN

Bernardo Pinto · Filipe Obrist · José Mendes · Mariana Perna · Rafaela Dias



**Advisors:** Susana Sargento, Pedro Rito, Filipe Cabral Pinto, Duarte Raposo

# OUR TEAM



Bernardo Pinto



Filipe Obrist



José Mendes



Mariana Perna



Rafaela Dias

01

# CONTEXT



# CONTEXT

- ★ SmartCities
- ★ Digital Twin
- ★ Aveiro Tech City Living Lab (ATCLL)  
<https://aveiro-living-lab.it.pt/citymanager>
- ★ Live!Urban



02

# PROBLEM





# PROBLEM

Aveiro's Europa Marathon 2024

03

# STATE OF ART



# STATE OF ART

## Building a Motorway Digital Twin in SUMO

Real-Time Simulation of Continuous Data Stream from Traffic Counters

<https://ieeexplore.ieee.org/document/9899796>

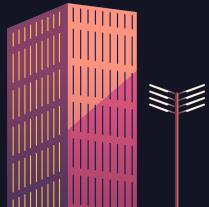
## Smart Mobility Digital Twin for Automated Driving

Design and Proof-of-Concept

<https://ieeexplore.ieee.org/document/10200728>

## Efficient Procedure of Building University Campus Models for Digital Twin Simulation

<https://ieeexplore.ieee.org/document/9913679>

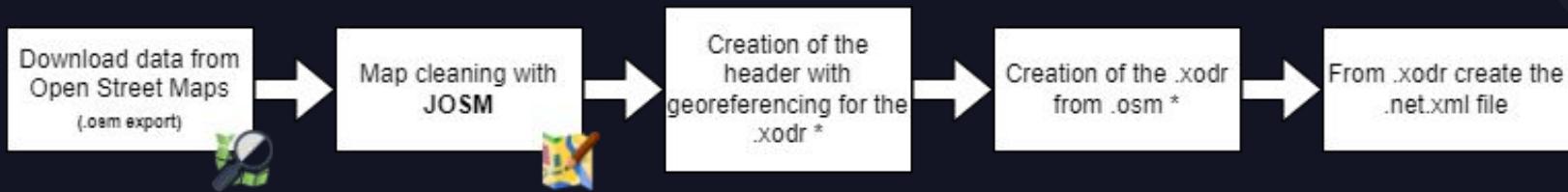


04

# CO-SIMULATION METHOD



# CO-SIMULATION METHOD

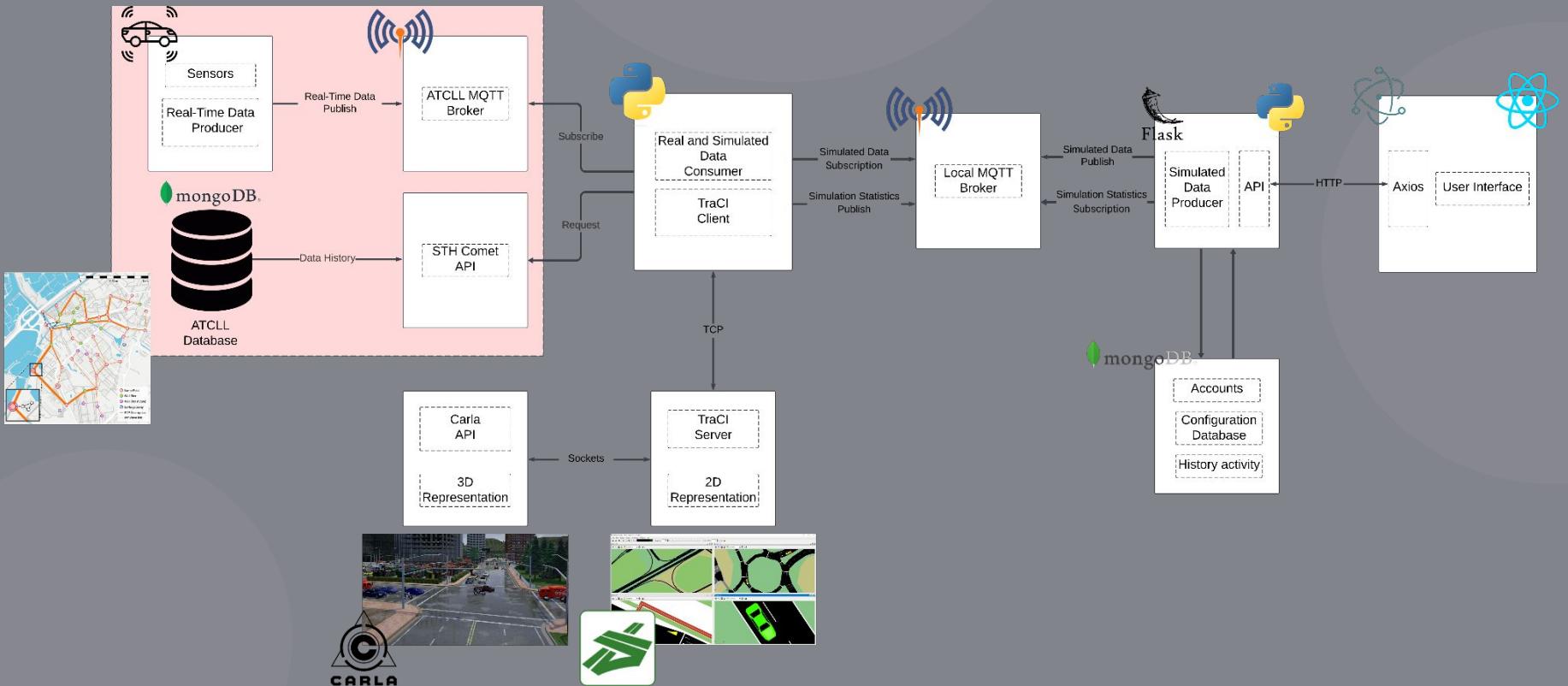


05

# ARCHITECTURE



# ARCHITECTURE

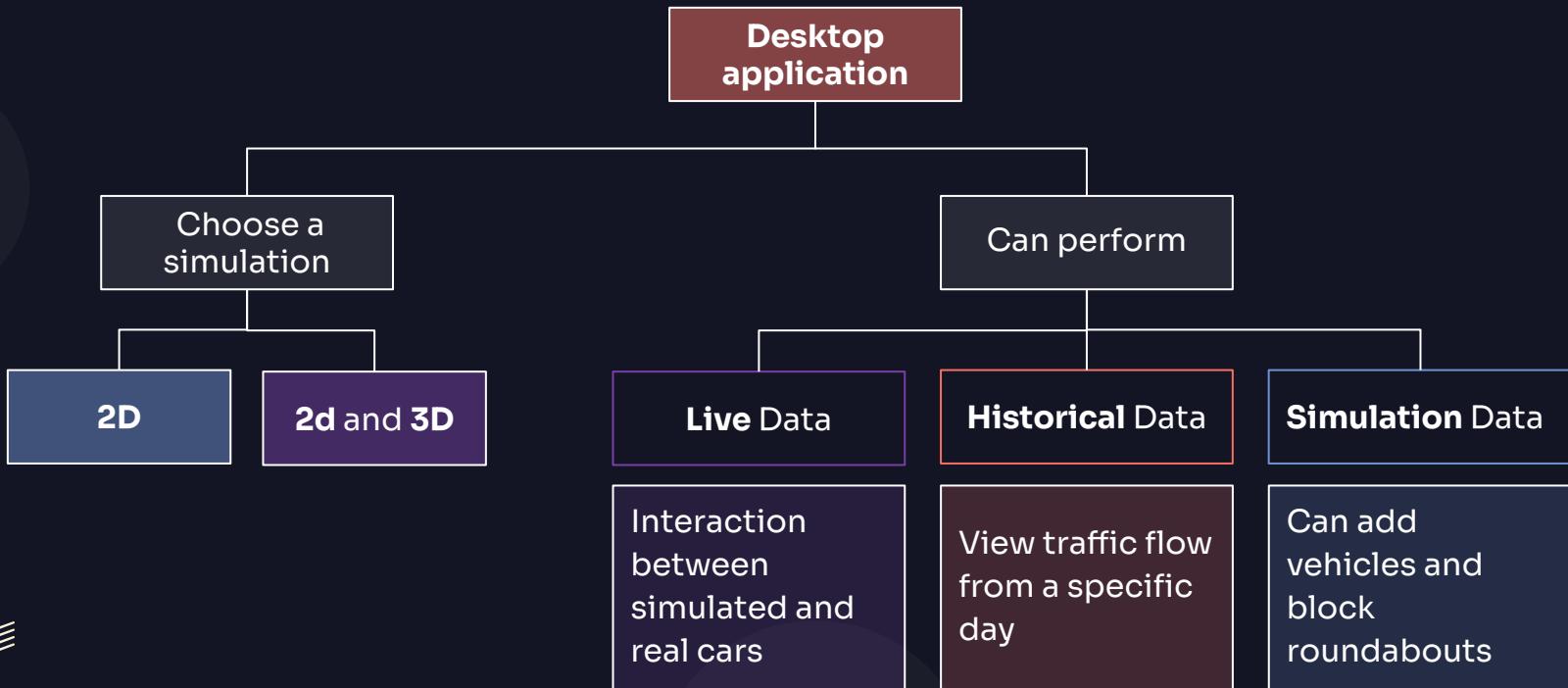


06

# FUNCTIONALITIES



# SYSTEM FEATURES



# SYSTEM FEATURES

## 2D

Communicates with TraCI API

Statistics

Control the traffic flow

## 3D

Extension in visualization

Interface for autonomous vehicles



# SIMULATIONS



# USER INTERFACE

01

Add random traffic

03

Road and roundabout blockage

05

Statistics

02

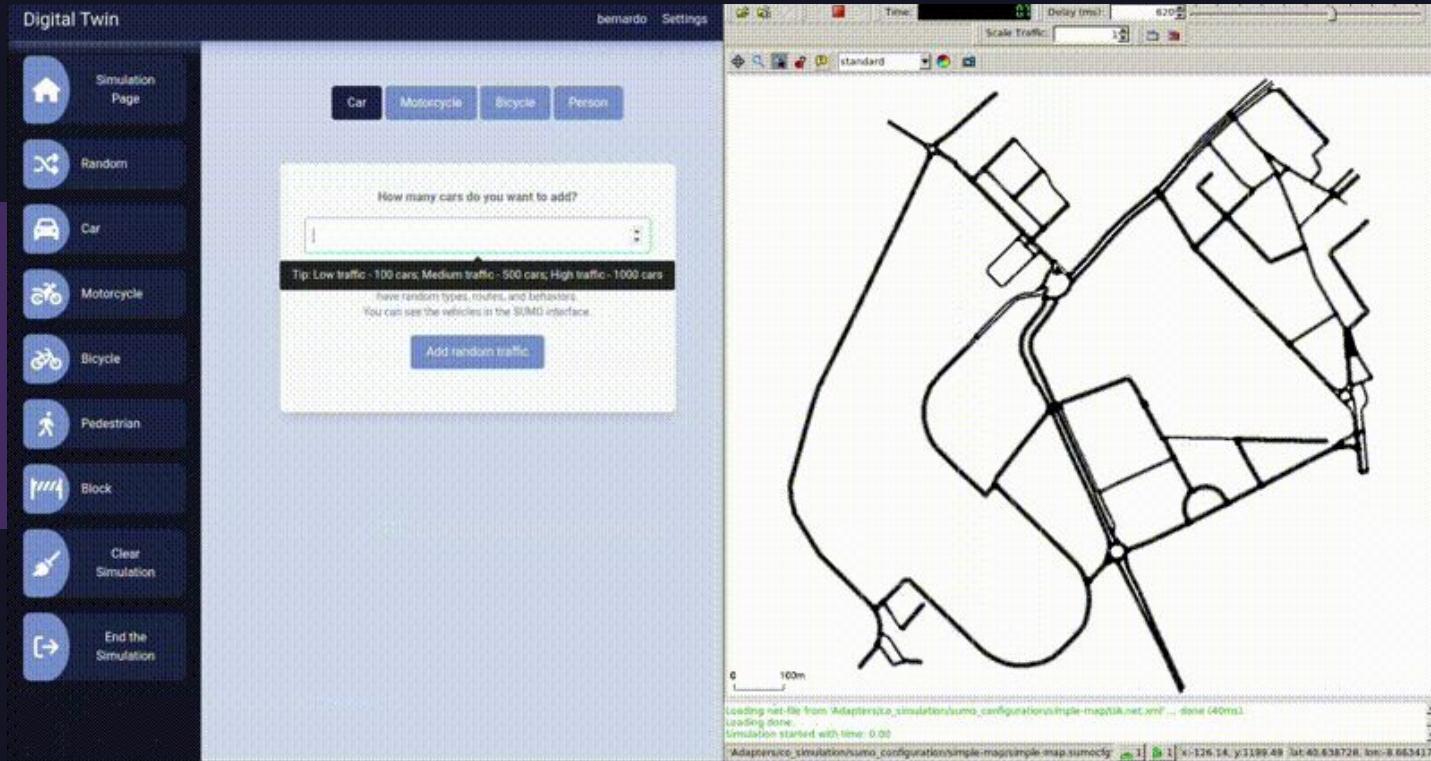
Add vehicles with defined routes

04

History and re-simulation



# ADD RANDOM TRAFFIC



01

Collect desired car count from user

02

Identify streets allowing traffic

03

Retrieve vehicle types

04

Perform insertion cycles per car count

05

Randomize vehicle types and route

06

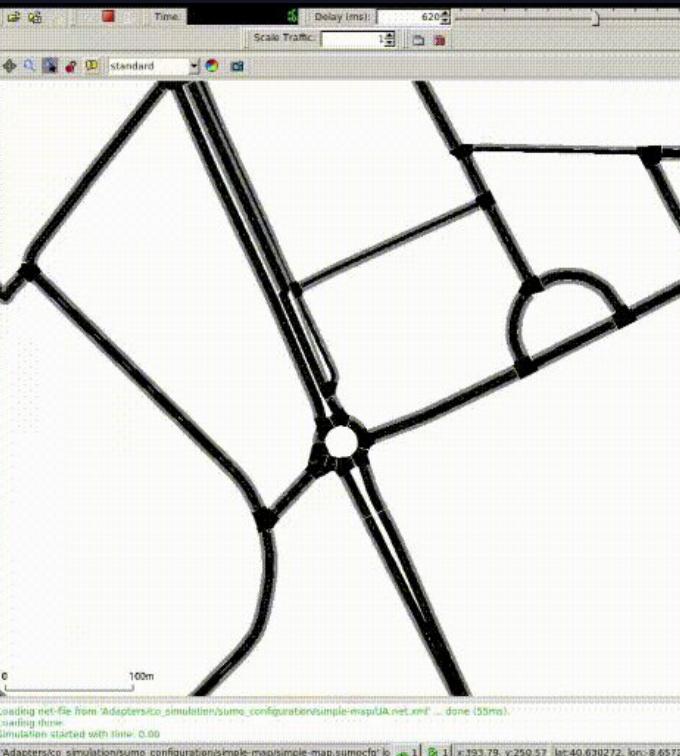
Insert vehicles with traci.vehicle.add



How to Add a Car:

- Step 1: Click the "Start Position" button and choose on the map where you want your car to start.
- Step 2: Click the "Finish Position" button and choose where on the map your car's destination is.
- Step 3: Click "Add a car".
- Step 4: Choose how many cars and their departure time.

Start Position   Finish Position   Clear markers  
Add car



# ADD VEHICLES WITH DEFINED ROUTES

01

Select route points on the map

02

Identify roads with  
traci.simulation.con  
vertRoad

03

Determine optimal path using  
Dijkstra's algorithm via  
traci.simulation.findRoute

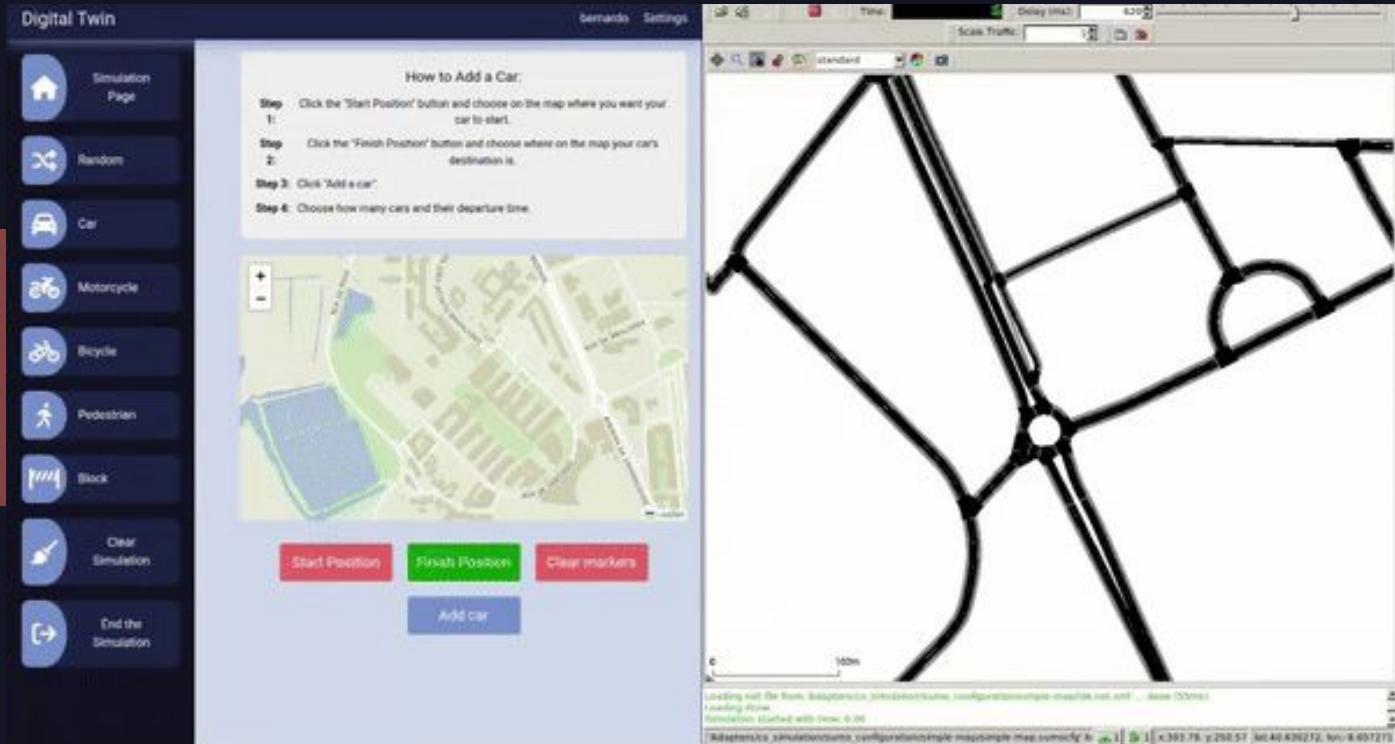
04

Create unique  
vehicle ID with  
timestamp

05

Insert vehicle and  
assign route with  
traci.vehicle.add

# ROAD AND ROUNDABOUT BLOCKAGE



**01**

Access  
"road.json" for  
edge data

**02**

Set edge  
speeds to  
zero

**03**

Block vehicle  
access using  
traffic algorithms

**04**

Ensure no  
vehicles during  
closure

## Digital Twin



The screenshot shows the Digital Twin interface. On the left, a sidebar lists various vehicle and pedestrian types. The main area has a map with several cars and a legend. A sidebar titled "How to Add a Car:" provides steps: 1. Click the "Start Position" button and choose on the map where you want your car to start. 2. Click the "Finish Position" button and choose where on the map your car's destination is. 3. Click "Add a car". 4. Choose how many cars and their departure time. Buttons for "Start Position", "Finish Position", "Clear markers", and "Add car" are visible. The bottom of the screen shows a terminal window with simulation logs.

# HISTORY AND RESIMULATION

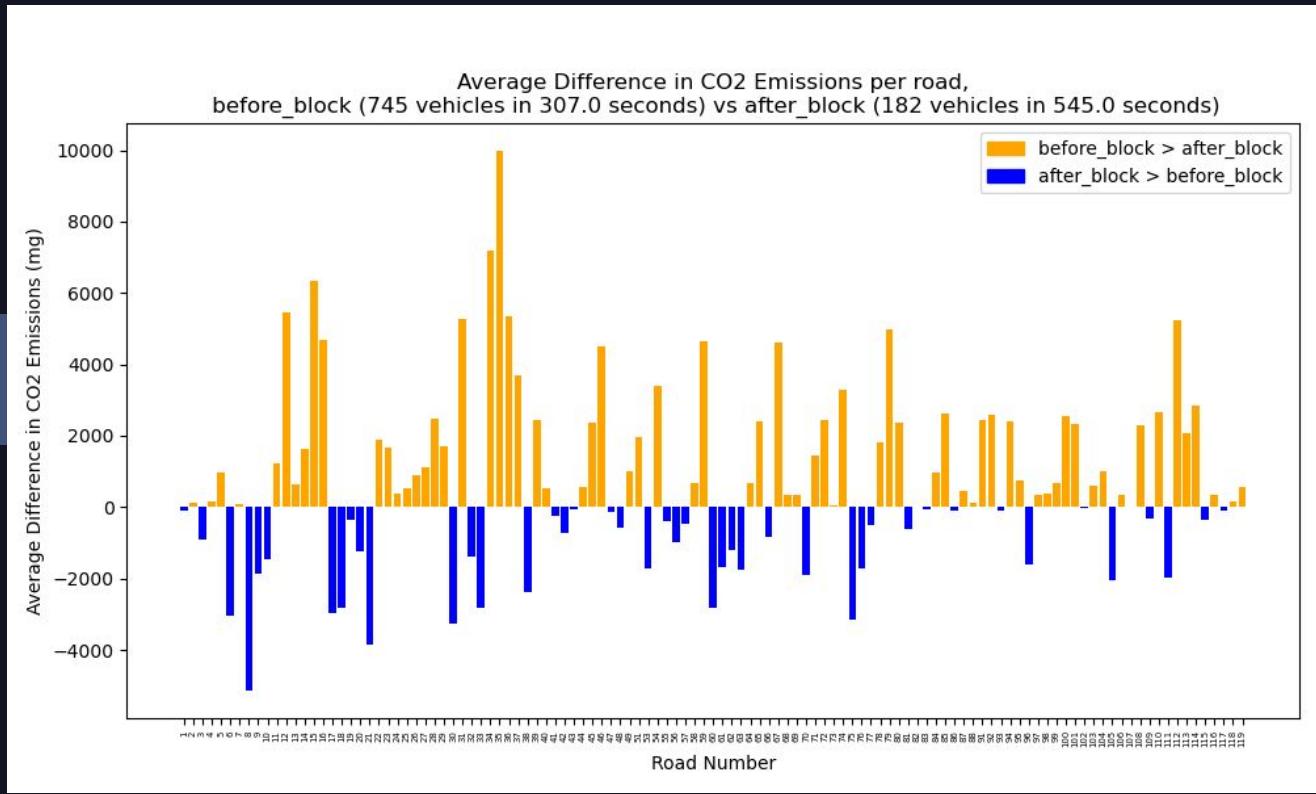
01

Save simulations with all vehicles, pedestrians, paths, and speeds

02

Resimulate scenarios to replicate exact traffic patterns and analyze statistics

# STATISTICS



01

Average CO2  
emission

02

Average  
fuel spent

03

Max number  
of cars

04

Total number  
of cars

05

Waiting  
time

07

# COLLISIONS



# COLLISIONS

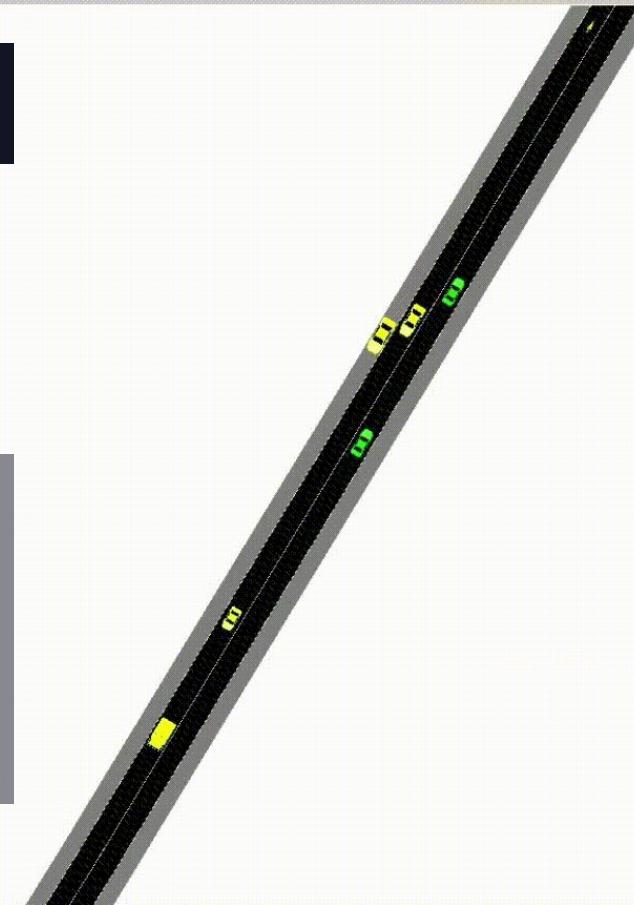
Real-time vehicles are  
always added

- ★ Vehicles received through the MQTT are treated as Simulated
- ★ These vehicles update their speed to match the version in the Physical Twin
- ★ It does this so that all vehicles can be treated equally, interacting as equally as well

# COLLISIONS

The vehicles adjust dynamically to each other, avoiding collisions

- ★ We considered that the logical thing to do was avoid collisions between vehicles
- ★ Vehicles maintain their live speed until they predict a collision and proceed to an emergency stop



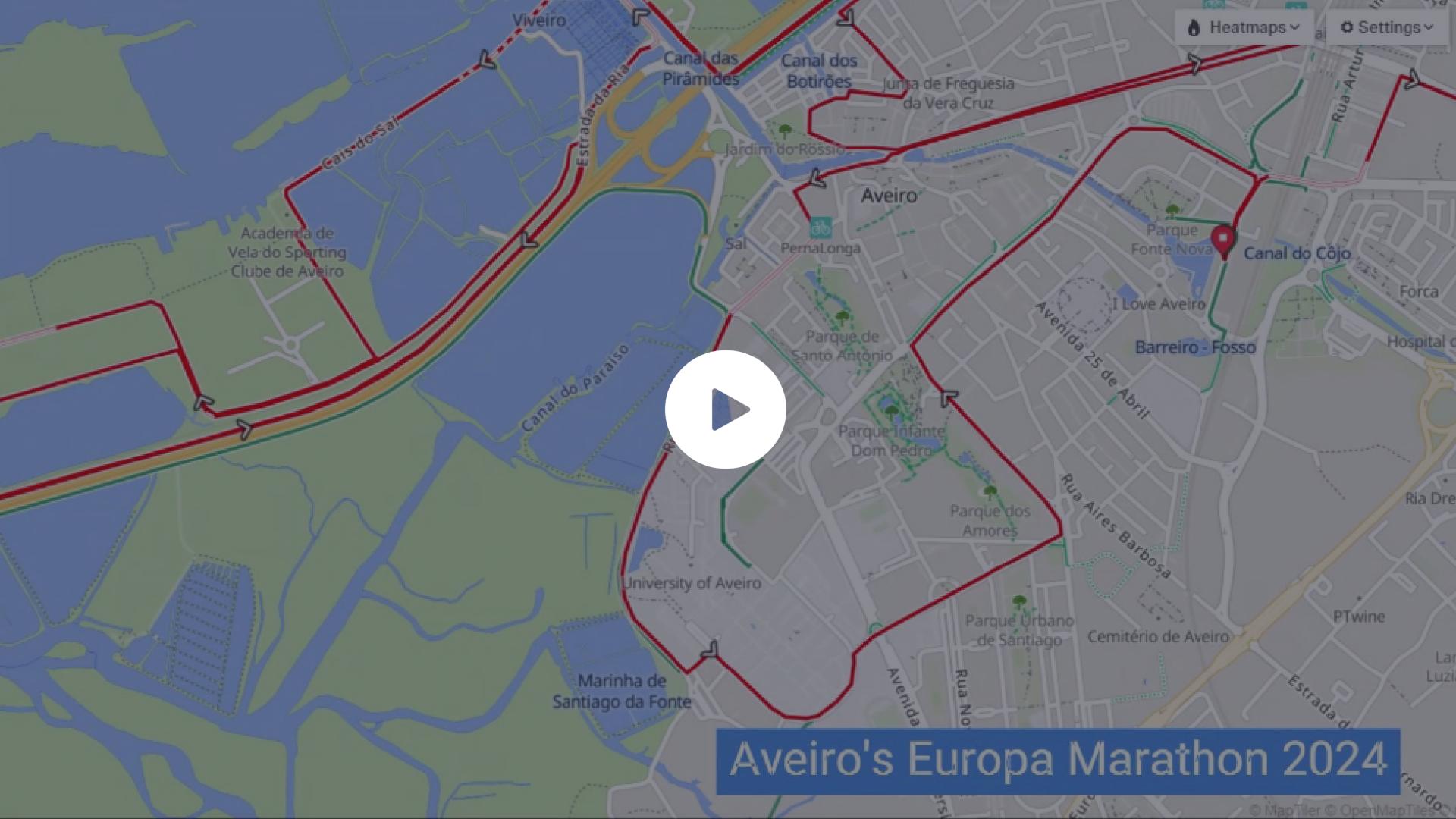
ning: No connection between edge '526' and edge '497' found.  
ning: No connection between edge '511' and edge '497' found.  
ning: No connection between edge '528' and edge '497' found.

apters/co\_simulation/sumo\_configuration/ruadapega/ruadapega.sumocfg loaded.

08

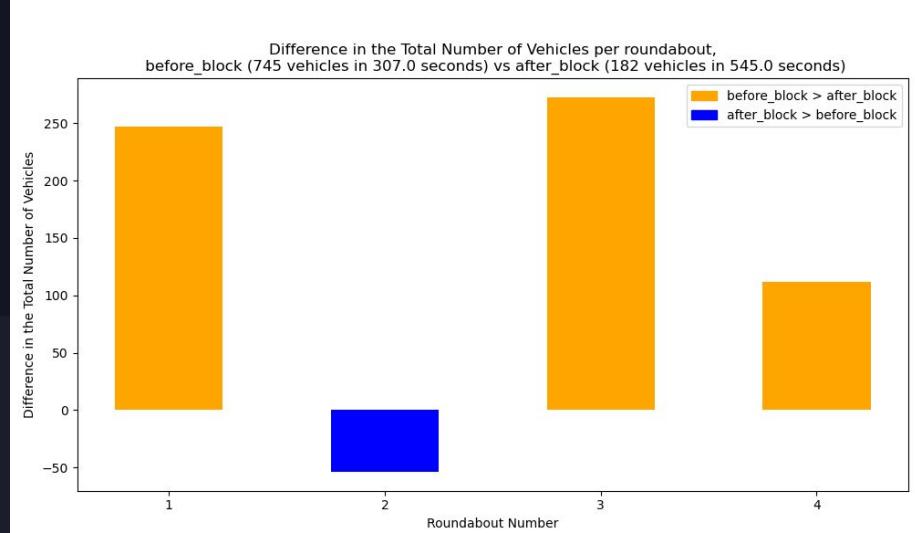
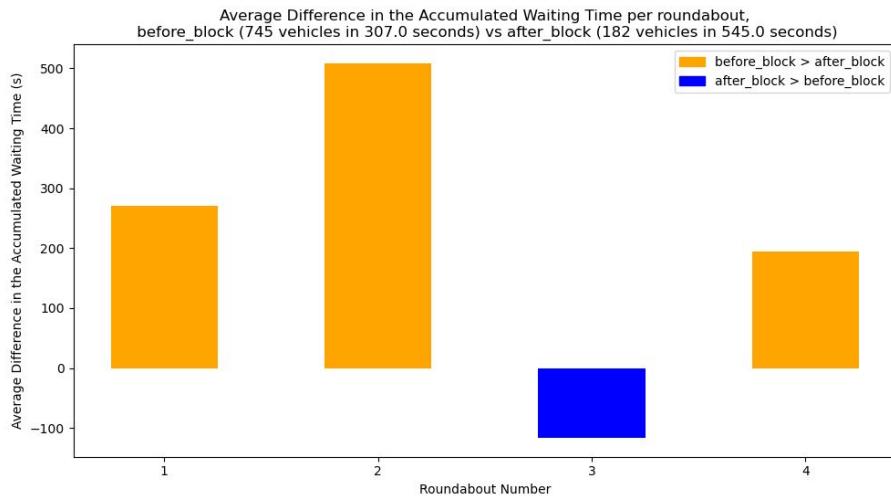
# DEMO





Aveiro's Europa Marathon 2024

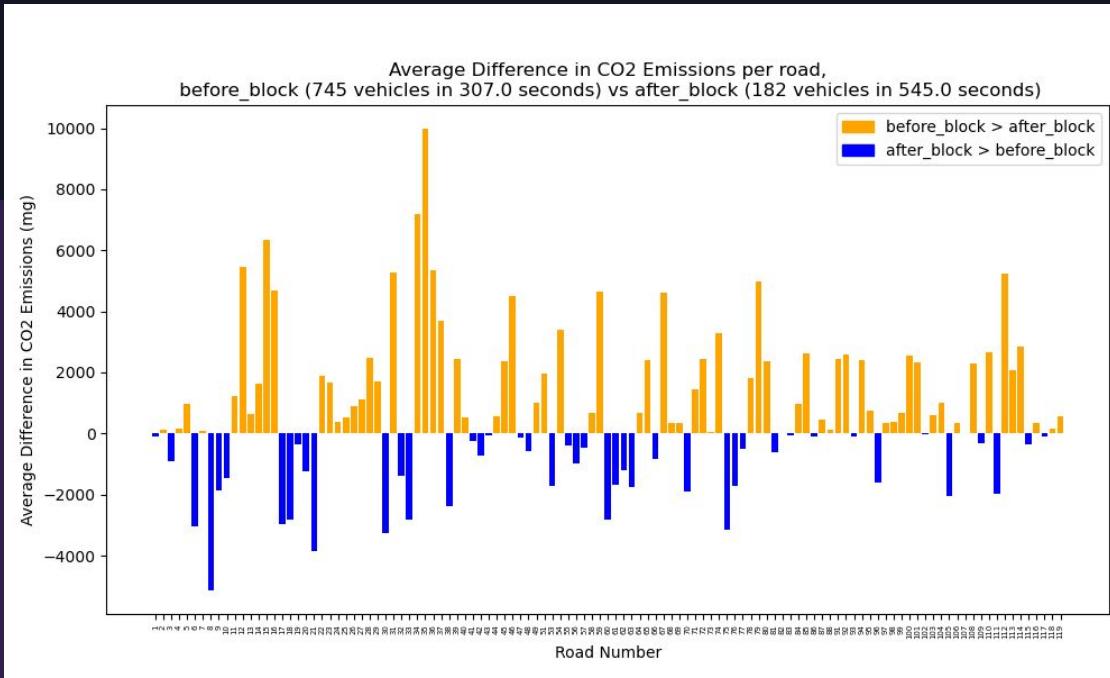
# RESULTS



Average Waiting Time  
per Roundabout

Total Number of Vehicles  
per Roundabout

# RESULTS



## Average CO2 Emissions per Road

08

# CONCLUSION



# Estudantes da UA selecionados para um dos maiores concursos mundiais de empreendedorismo

03 junho 2024

f    v    in

Três equipas de estudantes, que frequentam a disciplina de Empreendedorismo da Universidade de Aveiro (UA), foram selecionados para participar no Bootcamp internacional do Programa Jumpstarter. Este programa tem a duração de 8 meses e é promovido pelo Instituto Europeu de Inovação e Tecnologia. O objetivo estratégico deste programa é criar um impacto sustentável, impulsionando a inovação e o empreendedorismo nas regiões Centro-Oriental e do Sul da Europa.



## ENTREPRENEURSHIP CONTEST

09

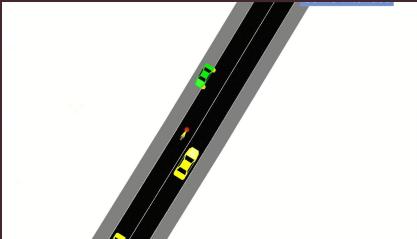
# FUTURE WORK



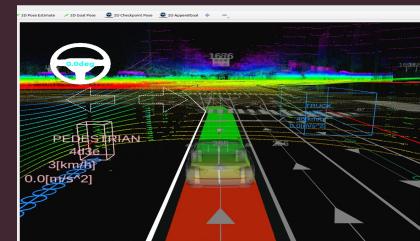
# FUTURE WORK

01

Scalate Live Data



02



Integration & Use  
of AUTOWARE  
(Autonomous Vehicles)

03

Real-life use



# Thanks!

Do you have any questions?

**CREDITS:** This presentation template was created by [Slidesgo](#), and includes icons by [Flaticon](#), and infographics & images by [Freepik](#)

