Traffic and bicycle accidents in Kyoto: Impact of POIs, cornercuts and road design

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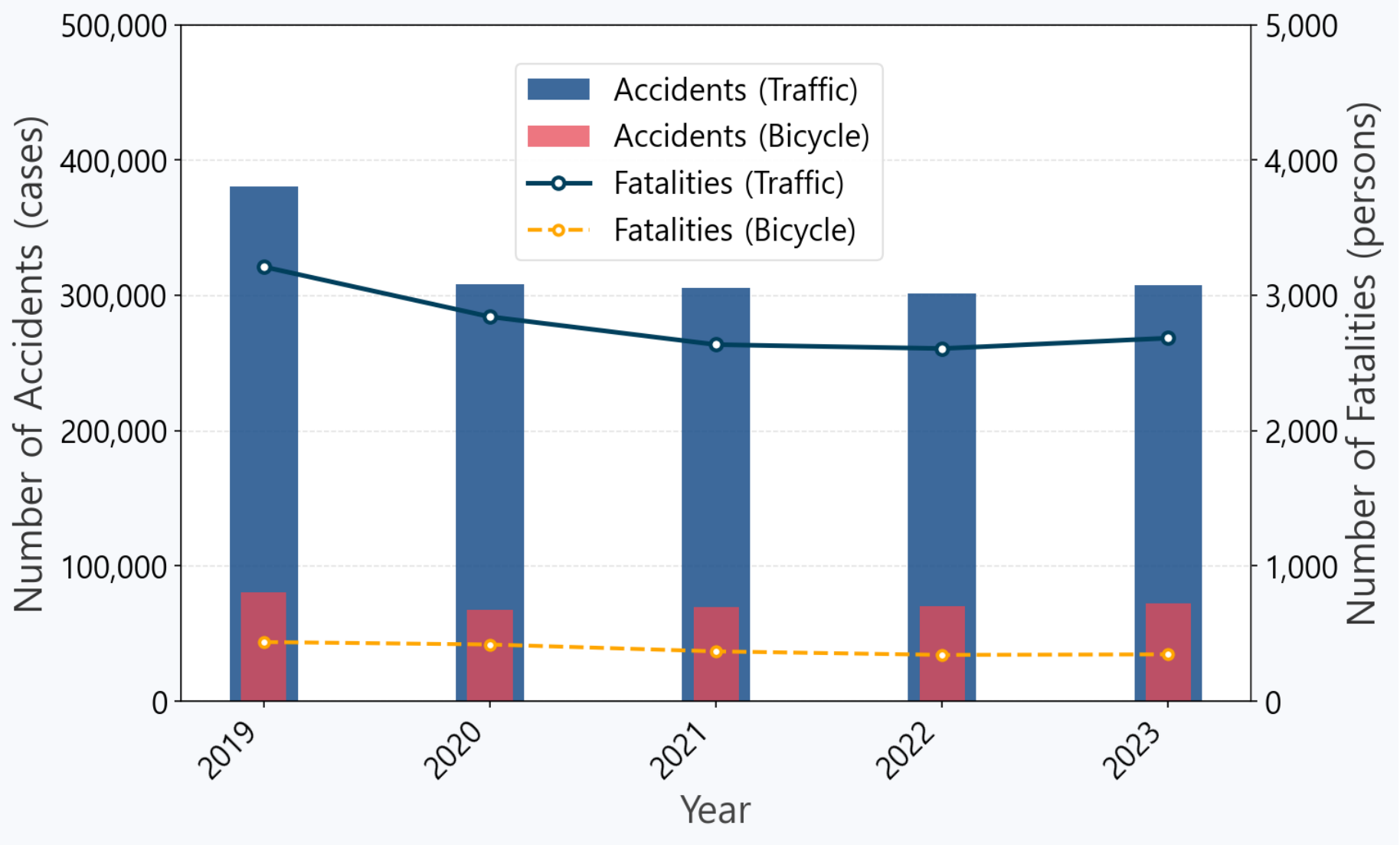
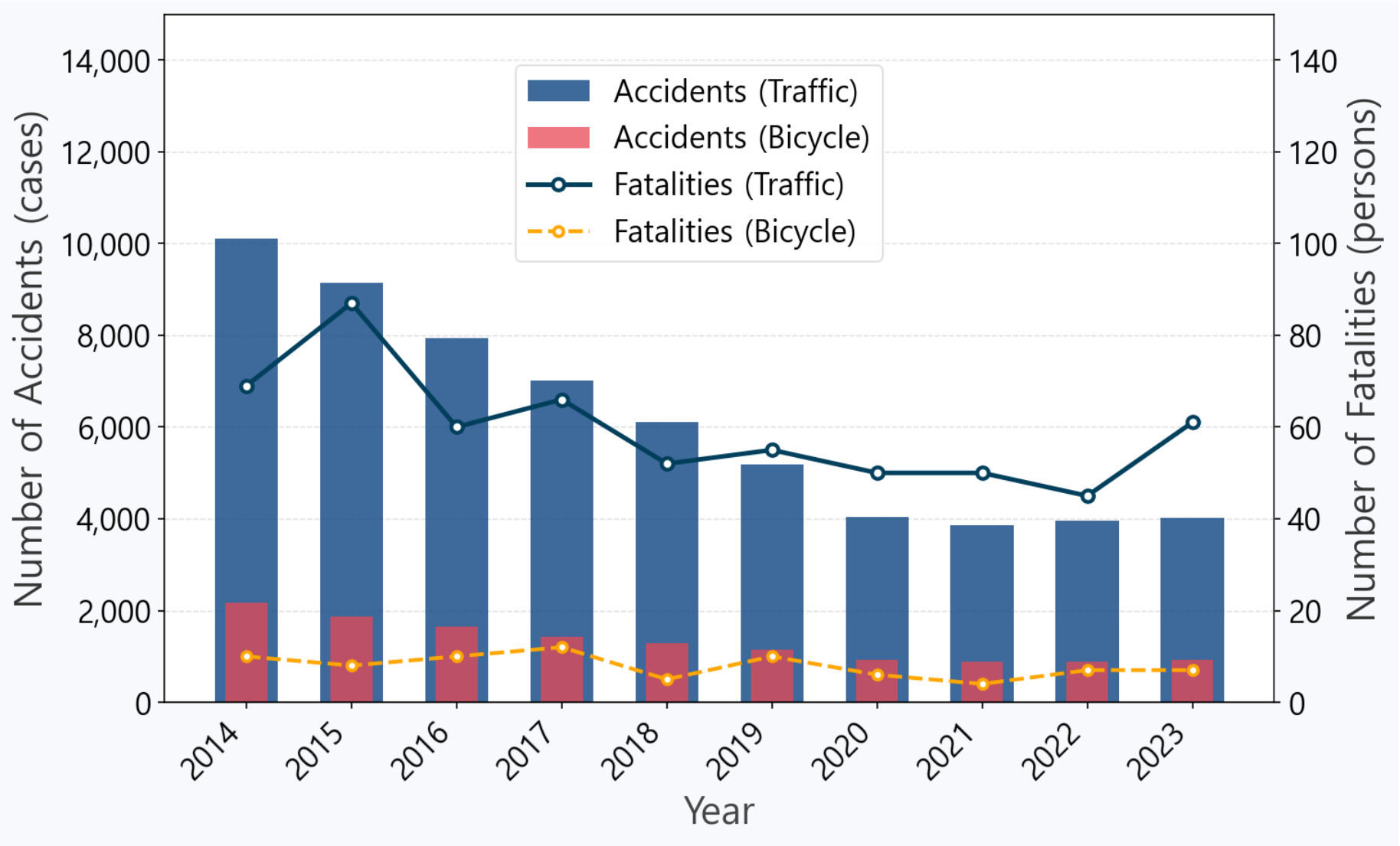
Traffic and bicycle accidents in Japan

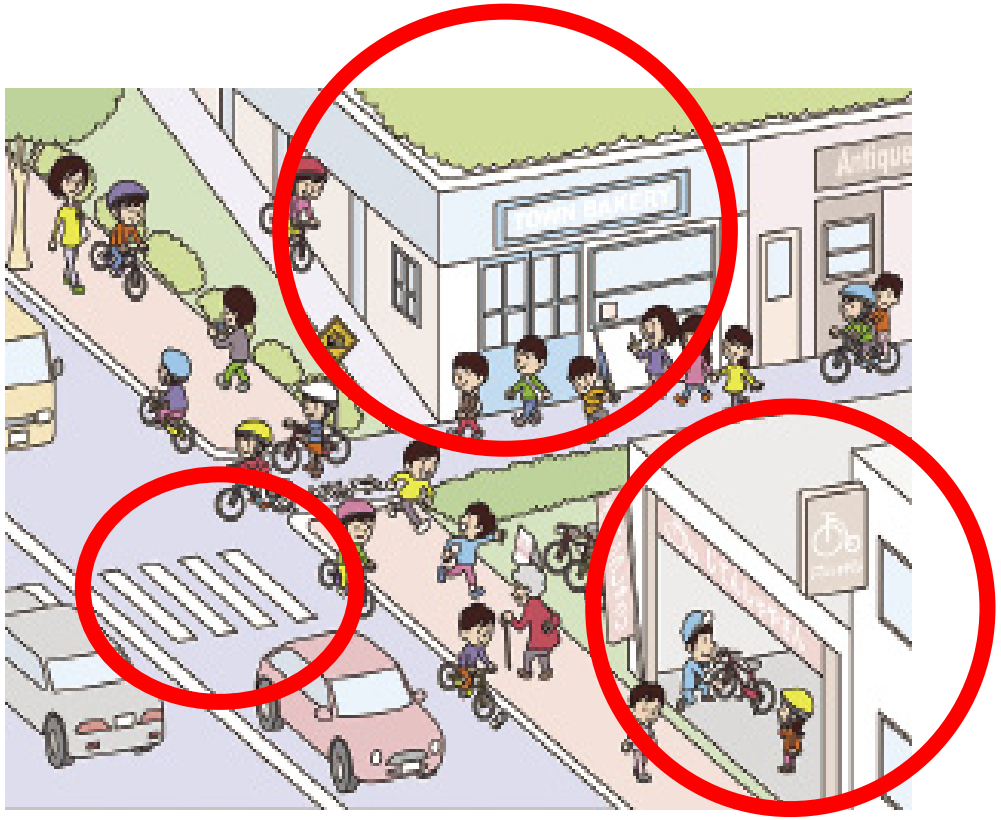


Traffic and bicycle accidents in Kyoto



Study 1: POIs and accidents

- Shops such as convenience stores are often located directly at junctions.
- Do such POIs contribute to accident risk controlling for other factors, including traffic volume and land-use
  - Causality is difficulty to establish!
- We focus specifically on smaller junctions



Study area and data used

Target Intersections

- 26,553 intersections located in the densely populated area of Kyoto City
- Among them, 1,124 intersections with available traffic volume data (≥10,000 vehicles/day)

Target Traffic Accidents

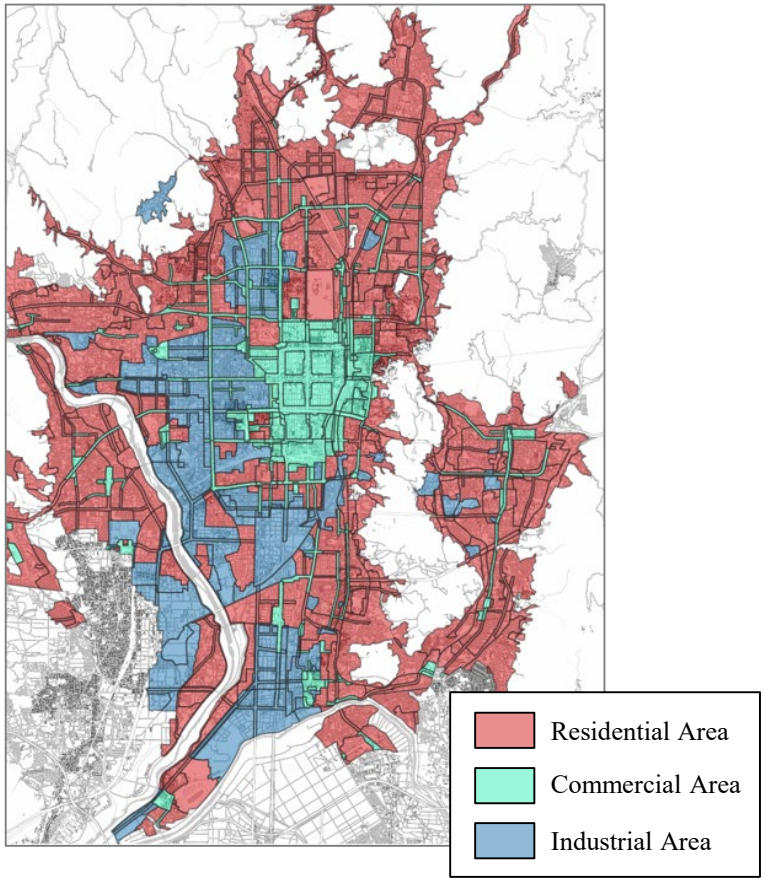
- 8,124 injury accidents in Kyoto City from 2017 to 2019

Spatial Data

- Building footprint data from OpenStreetMap
- Land-use data from the National Land Numerical Information (NLNI) dataset

Traffic Volume Data (used for a subset of intersections)

- 5-minute interval traffic counts at 331 locations in Kyoto City (2017–2019), published by JARTIC



Data preparation

Road network data obtained from OSM to construct intersection-level data

↓

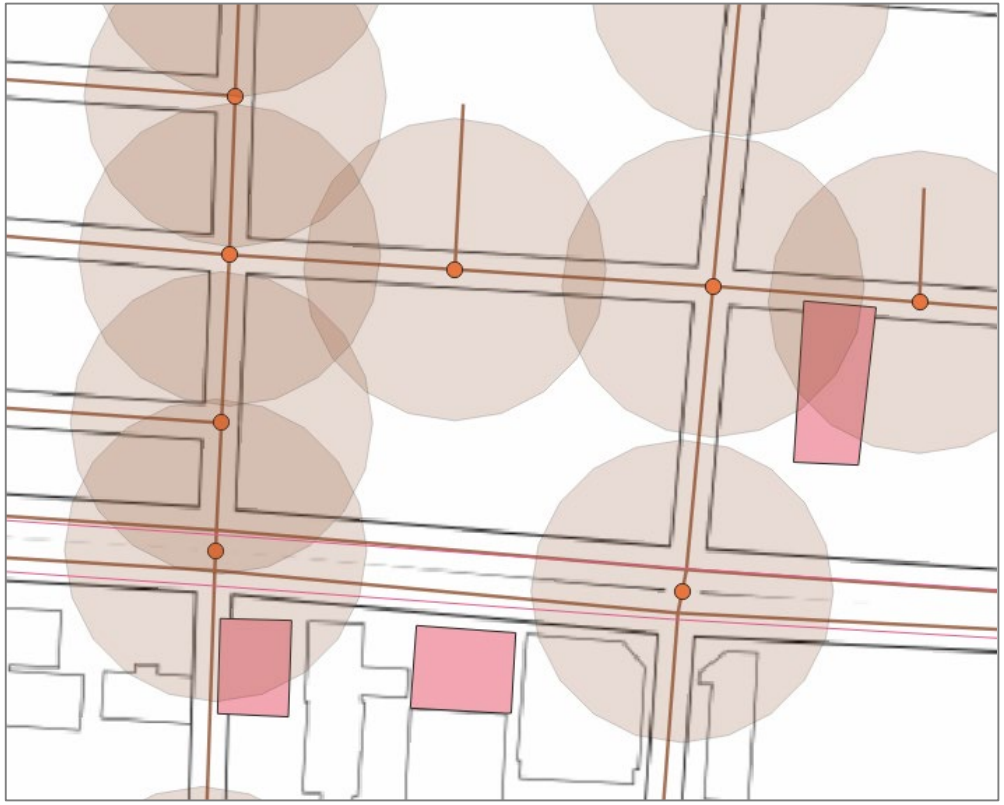
The presence of traffic signals and crosswalks within a 10m radius was identified

↓

The presence of surrounding facilities within a 30m radius was identified

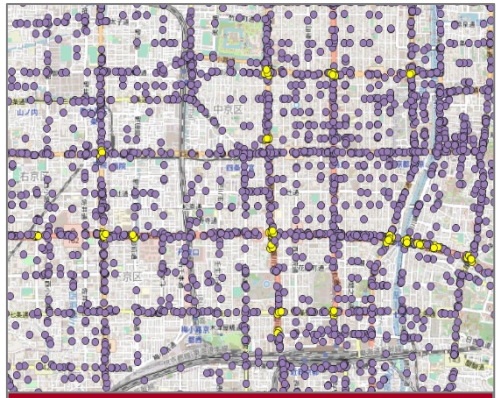
↓

Land-use type and population density data were merged

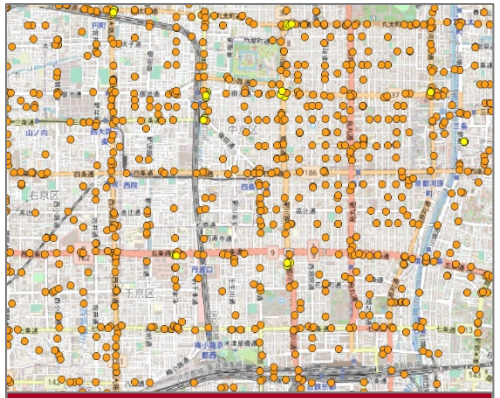


A 30m buffer around intersections and building footprint data (e.g., parking lots)

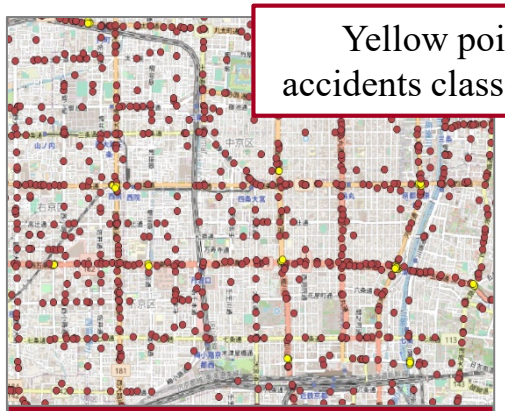
Accident hotspots



Car (30 m, 10 points)

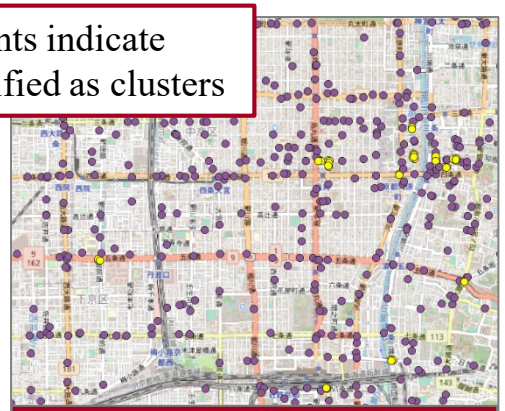


Bicycle (30 m, 5 points)



Yellow points indicate accidents classified as clusters

Motorcycle (30 m, 5 points)



Pedestrian (30 m, 3 points)

DBSCAN is applied to all traffic accident data. The results confirm that traffic accidents are concentrated around intersections.

- Cars and motorcycles show similar spatial patterns, with clusters distributed but concentrated at major intersections.
- Bicycle accidents are likely concentrated in areas with high population density.
- Pedestrian accidents are clustered around central commercial districts, particularly near Shijo Street.

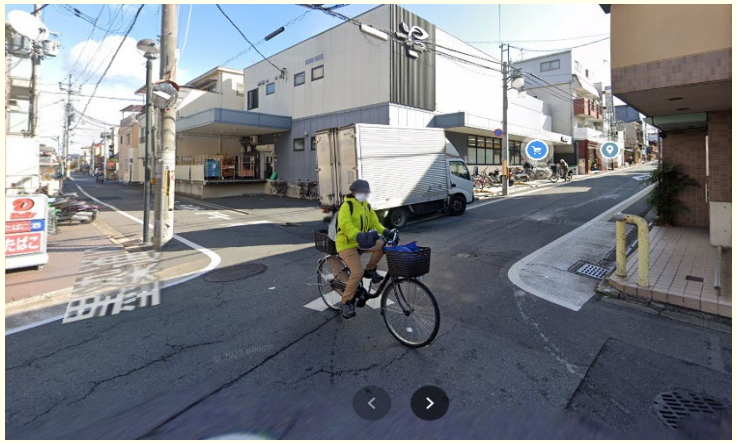
Junction examples

Small Intersection, with Restaurants, High Accident Frequency

- Located in a busy commercial district with high pedestrian activity
- Presence of an approach road with limited visibility
- Adjacent to Kawaramachi Street (narrow sidewalks),likely associated with high bicycle traffic

Small Intersection, with Supermarket, High Accident Frequency

- Narrow roadway with little or no sidewalk space
- A parking lot located near the intersection, likely generating frequent vehicle, motorcycle, and bicycle movements



* Source: Google Maps Street View

Junction examples (2)

Medium Intersection, with Convenience Store, High Accident Frequency

5 accidents over 3 years

- Car × Motorcycle: 2
- Car × Pedestrian: 2
- Motorcycle × Bicycle: 1

High traffic volume, limited visibility

Large Intersection, with Park, No Accidents

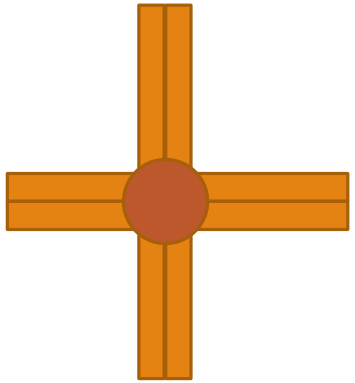
- Wide sidewalk corners and good visibility.
- Areas with parks tend to have more available space, which may allow for wider sidewalks and improved sight distance.

* Source: Google Maps Street View

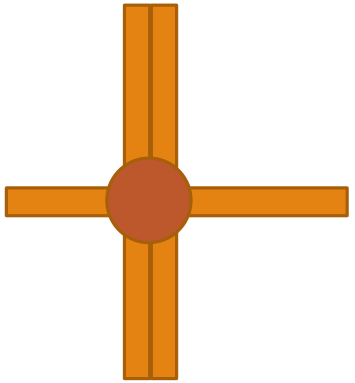
Intersection types

Intersections are classified into three types:

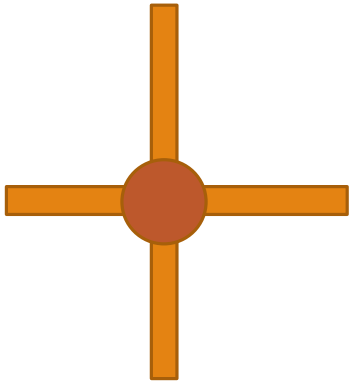
- Large Intersection: two or more lanes on both approaches
- Medium Intersection: two or more lanes and a single-lane road
- Small Intersection: single-lane roads



Large



Medium



Small

Regression analysis: Junction types

Variable	Large Intersections	Medium Intersections	Small Intersections
Constant	-0.3689 †	-1.1694 **	-3.0962 **
Signal	1.969 *	1.2159 **	2.2278 **
Crosswalk	0.3723 †	0.4931 **	0.5717 **
Population Density	-1.66×10^{-05}	-3.32×10^{-06}	6.21×10^{-06}
Commercial Area	0.9002 **	1.0991 **	1.1854 **
Industrial Area	0.5887 *	0.6451 **	0.5417 *
Residential Area	-0.7445 *	0.1139	0.185
Park	-0.7409 *	-0.4133 **	-0.0295
Restaurant	0.4433	0.2358 *	0.534 *
Supermarket	0.224	0.5695 **	1.0836 **
Convenience Store	-0.1936	0.8911 **	1.0459 **
Bus Stop	0.0462	0.3592 **	0.0106
Station	1.1334	0.342	-0.6026
Parking Lot	-0.1504	0.2171 **	0.2802 *
Number of Target Intersections	762	5916	19875
Number of Accident Intersections	524	2383	1282
Adjusted R-squared	0.2125	0.1119	0.0419

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Signals and crosswalks are significantly positive.

→ this may reflect the influence of higher pedestrian and vehicle volumes at these locations.

The likelihood of traffic accidents across land-use types appears to follow the order: commercial areas, industrial areas, and then residential areas.

→ commercial areas tend to have more pedestrians, whereas industrial areas tend to have more vehicles.

Pedestrian–Vehicle / Vehicle–Vehicle Accidents

Variable	Pedestrian–Vehicle	Vehicle–Vehicle
Constant	-4.8868 **	-3.2323 **
Signal	2.1531 **	1.9992 **
Crosswalk	0.8779 **	0.3329
Population Density	1.03E-06	4.76E-06
Commercial Area	1.4423 **	1.1387 **
Industrial Area	0.5119 **	0.5426 **
Park	0.268	-0.1186
Restaurant	1.0397 **	0.3472 *
Supermarket	1.7297 **	0.8111 **
Convenience Store	0.9734 **	0.9845 **
Bus Stop	-0.5569	0.1736
Parking Lot	0.2289	0.2588 **
Number of Target Intersections	19875	19875
Number of Accident Intersections	250	1067
Adjusted R-squared	0.07144	0.0329

† p < 0.10, * p < 0.05, ** p < 0.01

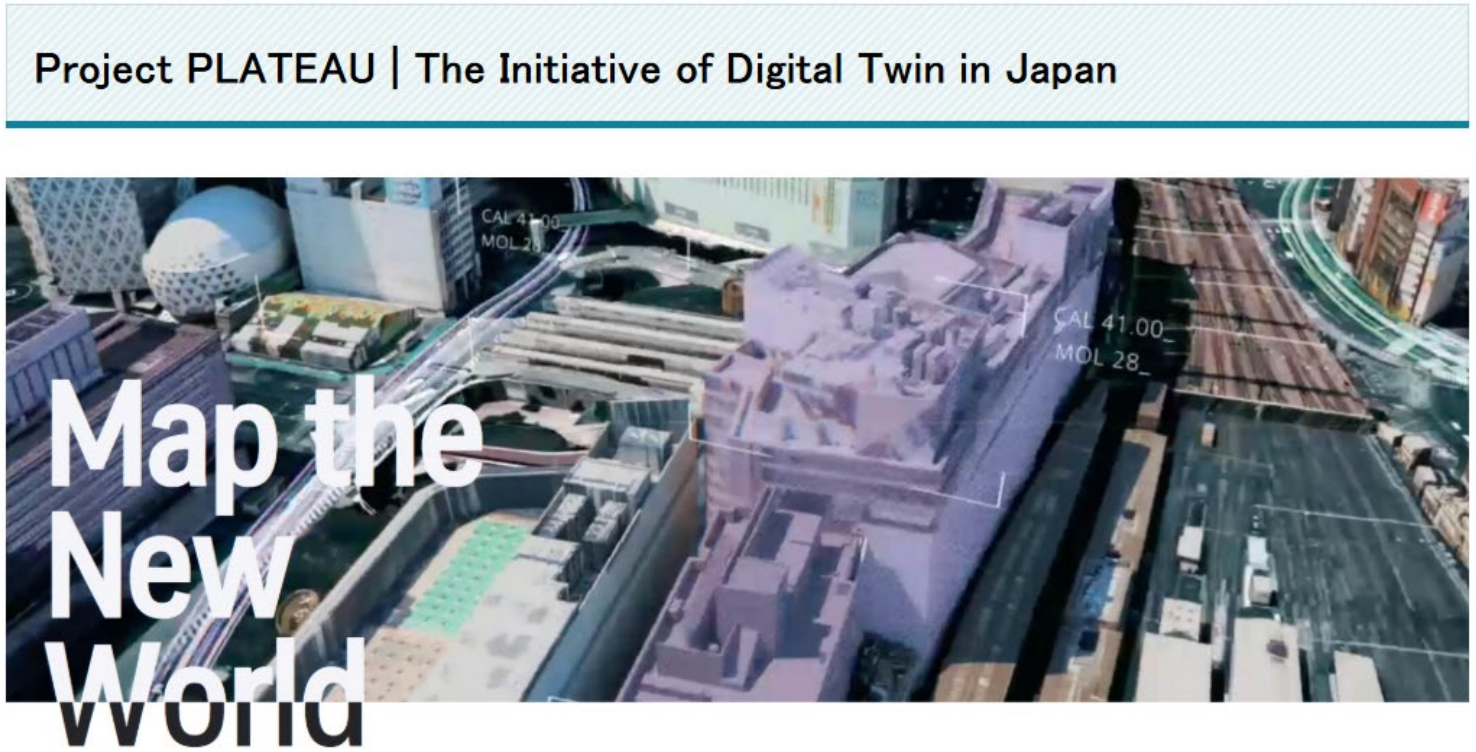
Restaurants, supermarkets, and convenience stores show positive and significant effects for both accident types; however, the magnitudes are substantially larger for pedestrian–vehicle accidents.

These facilities are more strongly associated with conflicts involving pedestrians, likely due to increased pedestrian activity and mixed traffic movements near the intersection.

Parking lots also show a significantly positive effect.

This likely relates to frequent vehicle access movements near intersections.

Study 2: Further analysis with PLATEAU data

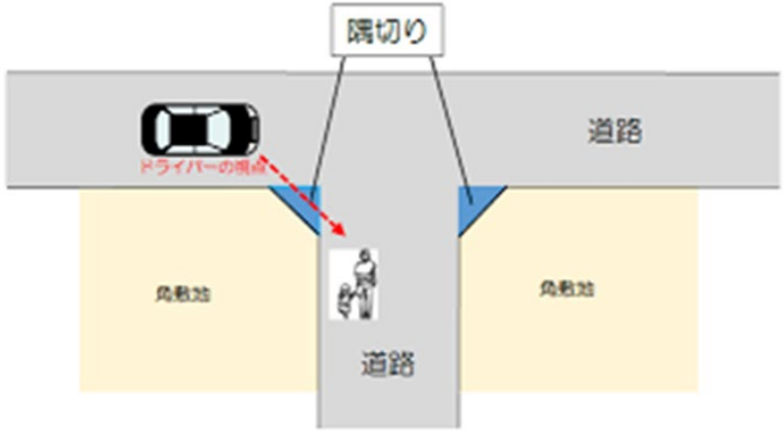


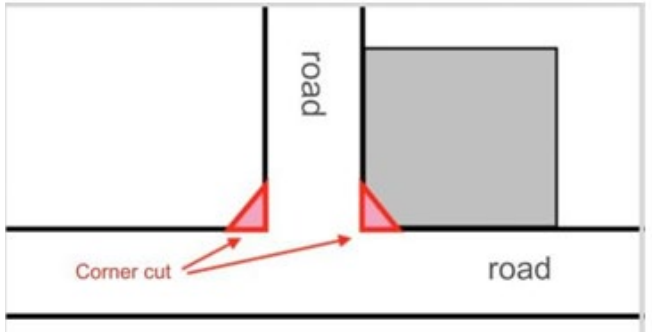
"Launched in 2020, PLATEAU continues to grow as a platform for the participation of many local governments, private companies, and diverse researchers, engineers, and creators.

PLATEAU is a platform for urban management, consolidation of urban functions, and sustainable urban development.
The digital transformation of city planning based on PLATEAU will solve social and regional issues."

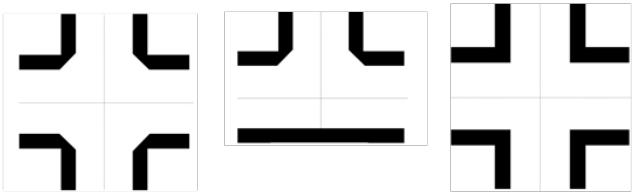
Field of view quantified by “corner cuts”

The number of “corner cuts” was calculated according to the number of vertices at the intersection.





Example of intersection geometry and number of corner-cuts



4 cuts 2cuts 0cuts

Number of vertices	Number of corner cuts
8 or more	4
7	3
6	2
5	1
4 or less	0

Corner-cut：Cut corners facing the street to increase visibility at intersections.

Junction examples

Kawabata Street

Number of corner cuts: 3

(17 accidents in 5 years)

Ayanokoji

Number of corner cuts: 0

(2 accidents in 5 years)

* Source: Google Maps Street View

Regression analysis

	Coefficient	t-value	
costant term	-0.112	-19.876	**
Intersection area	0.005	156.416	**
Numer of corner cuts	-0.085	-23.445	**
Convenience store dummy	0.208	5.934	**
Supermarket dummy	0.079	1.321	
Park dummy	-0.100	-6.114	**
Restaurant dummy	0.183	9.745	**
Station dummy	0.301	4.030	**
school dummy	0.159	1.221	
Kindergarten dummy	-0.095	-1.999	*
Bus stop dummy	0.025	1.317	
Parking lot dummy	0.069	6.700	**
Traffic light dummy	0.572	20.721	**
Crosswalk dummy	0.227	10.173	**
Adjusted coefficient of determination		0.533	

** 1% significant * 5% significant † 10% significant

- Corner cuts significant with expected sign - good proxy for visibility?
- Other parameters stay larger unchanged

- Note: Intersection area as surrogate variable for flow

Ongoing research: Focus on bicycle accidents

Public concern and policy response

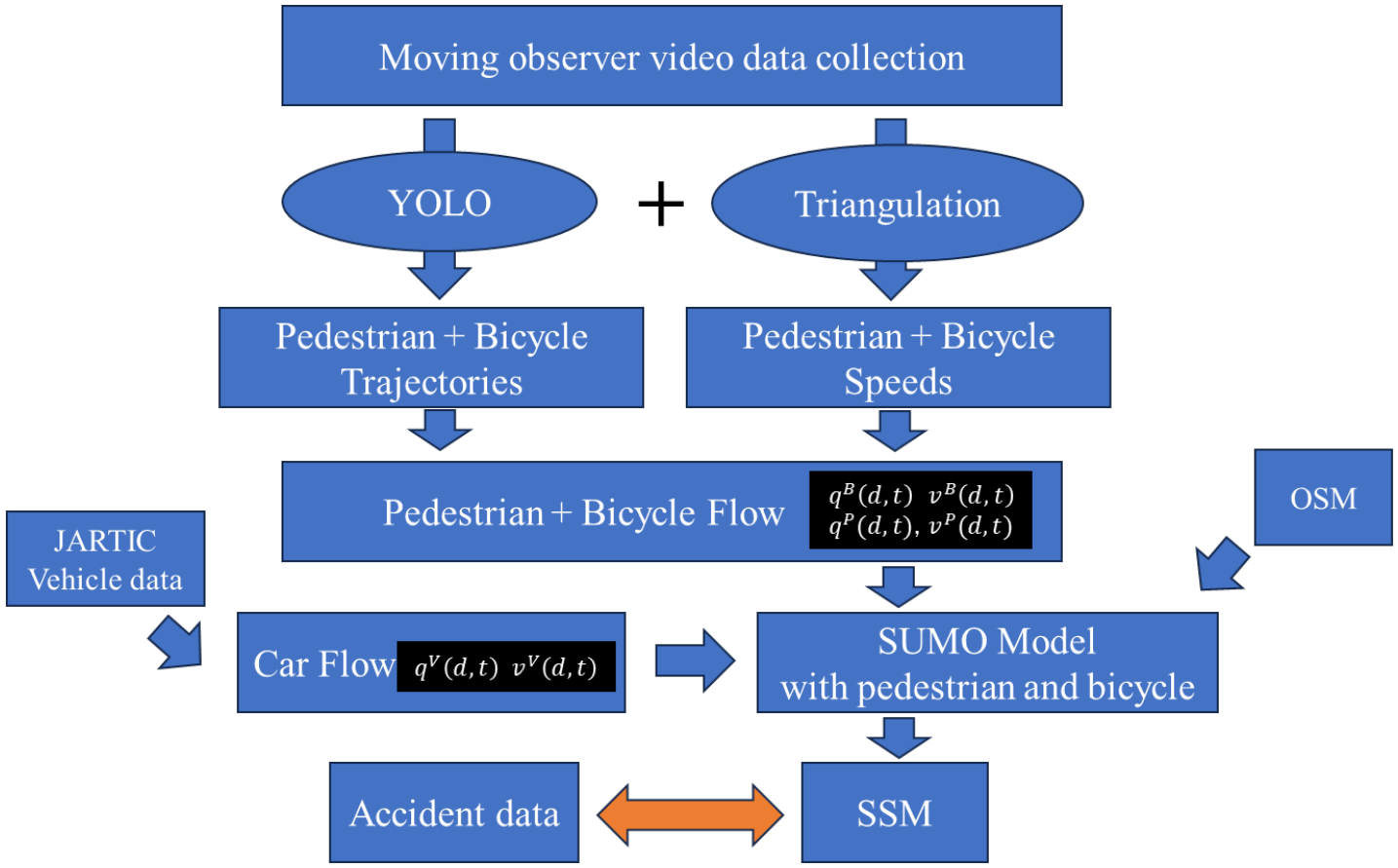
Media reports highlighting unsafe and improper bicycle riding in urban areas

Recent regulatory amendments and enhanced penalty systems for bicycle traffic

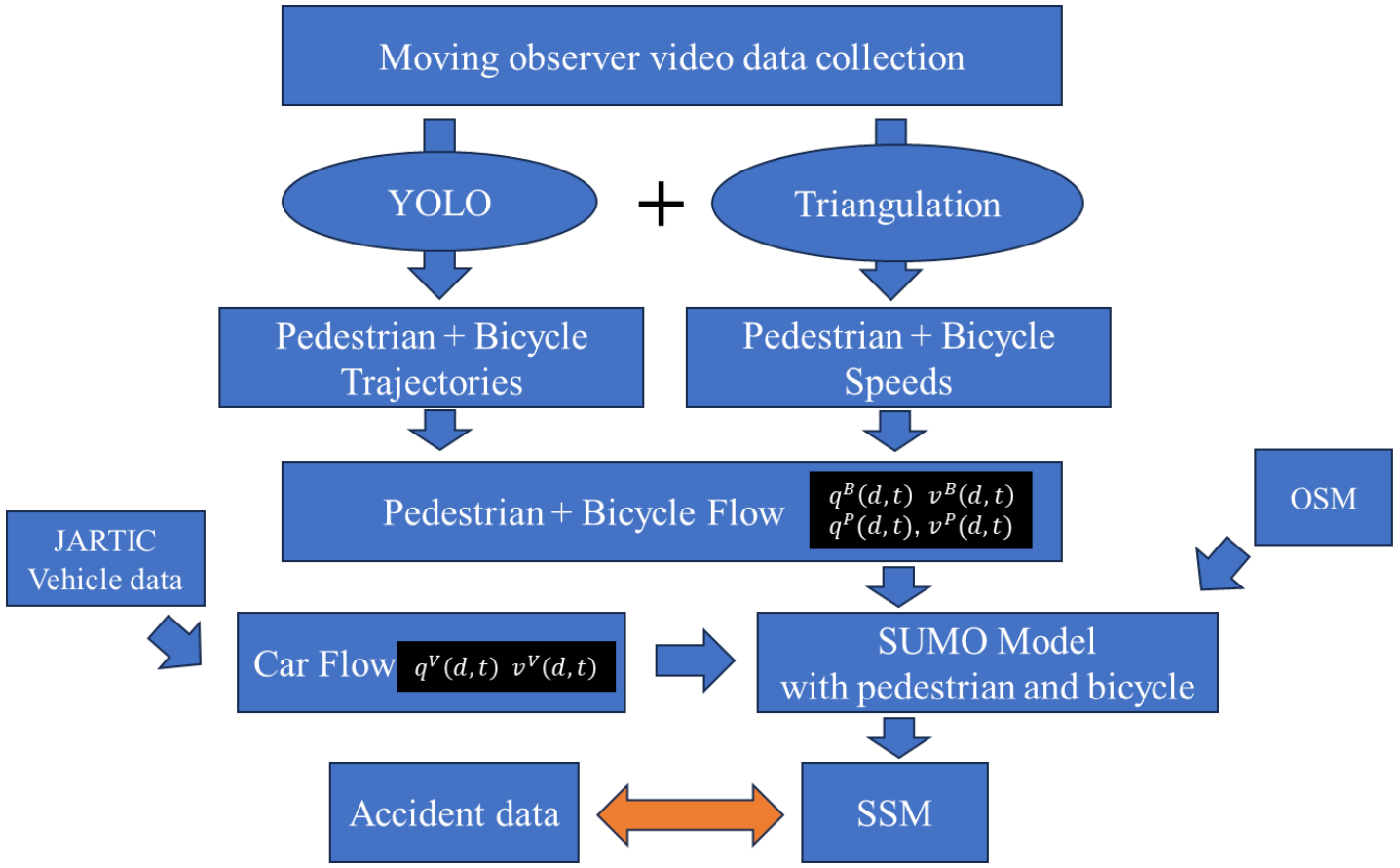
“Bike lanes” in Kyoto

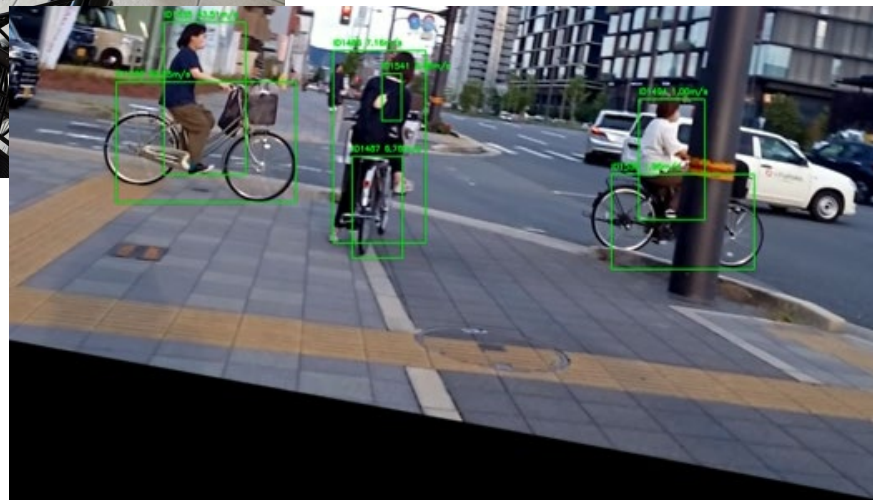
Public concern and policy response (2)

Ongoing research: Focus on bicycle accidents

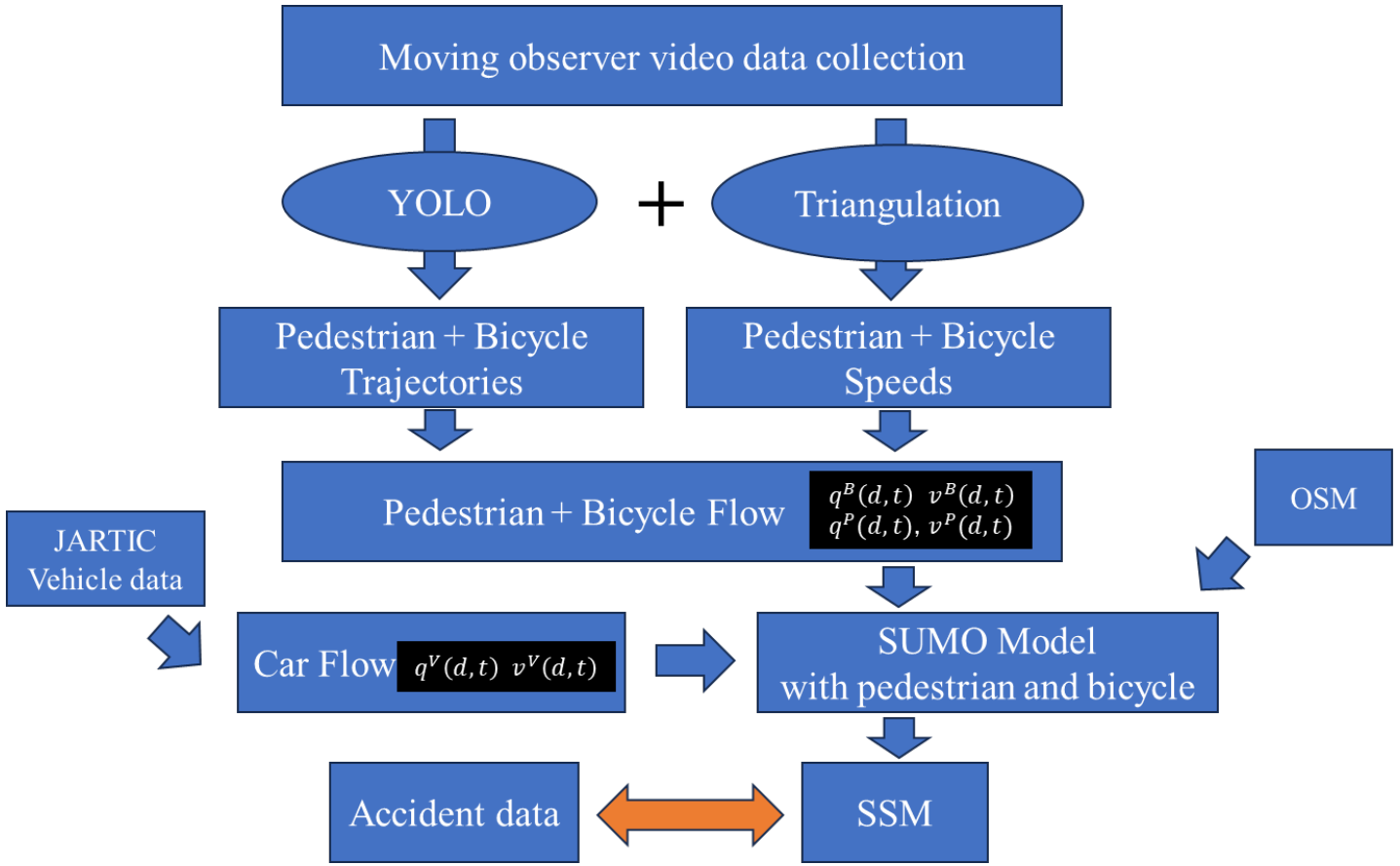


Ongoing research: Focus on bicycle accidents

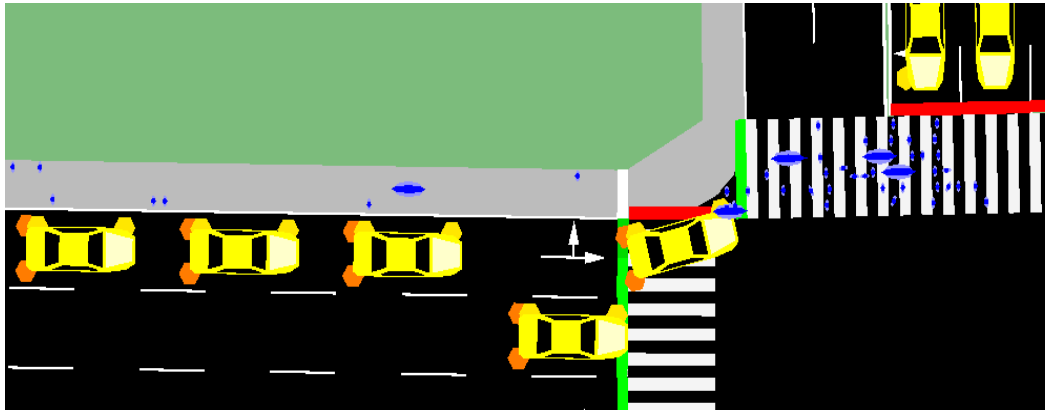




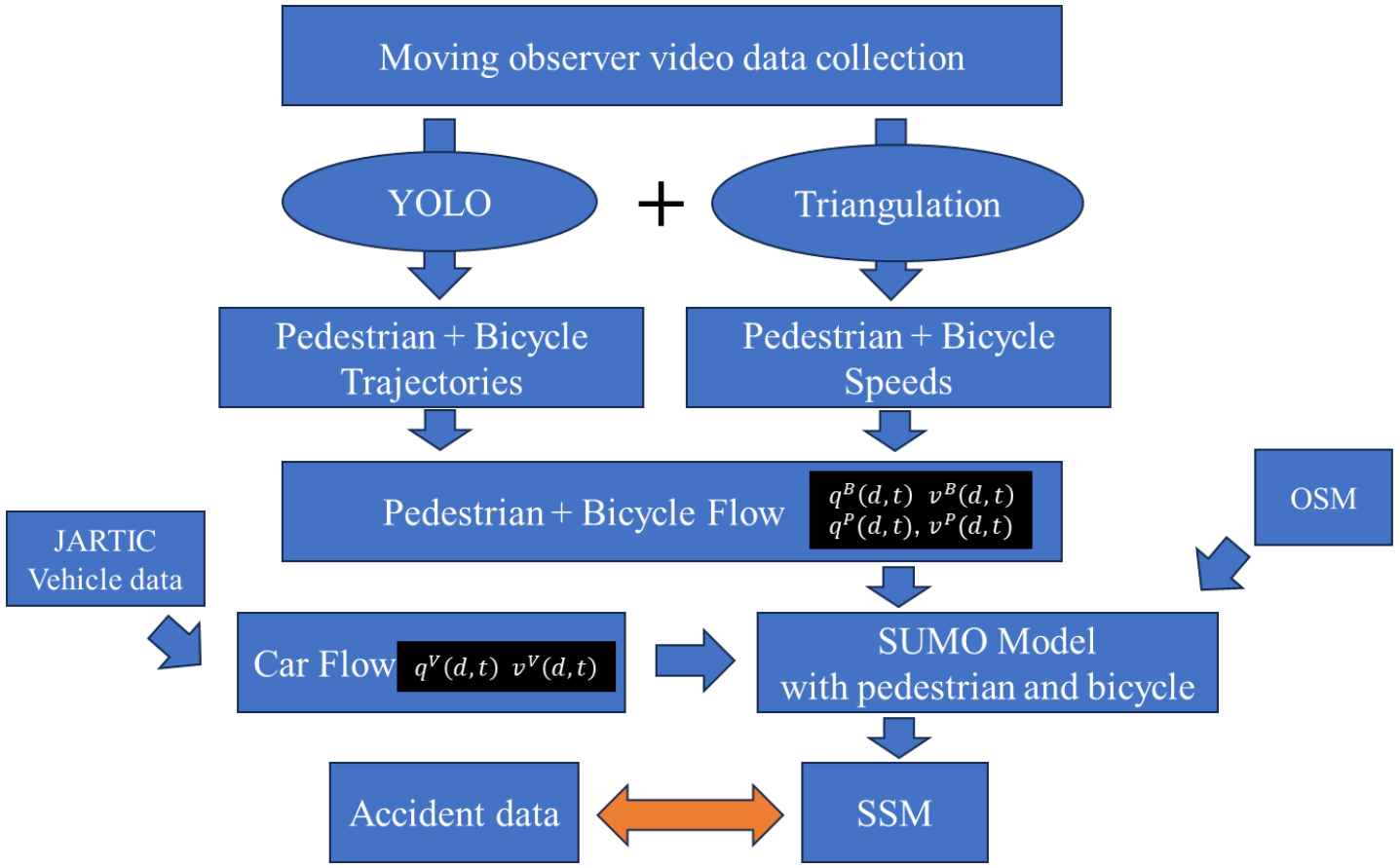
Ongoing research: Focus on bicycle accidents



SUMO

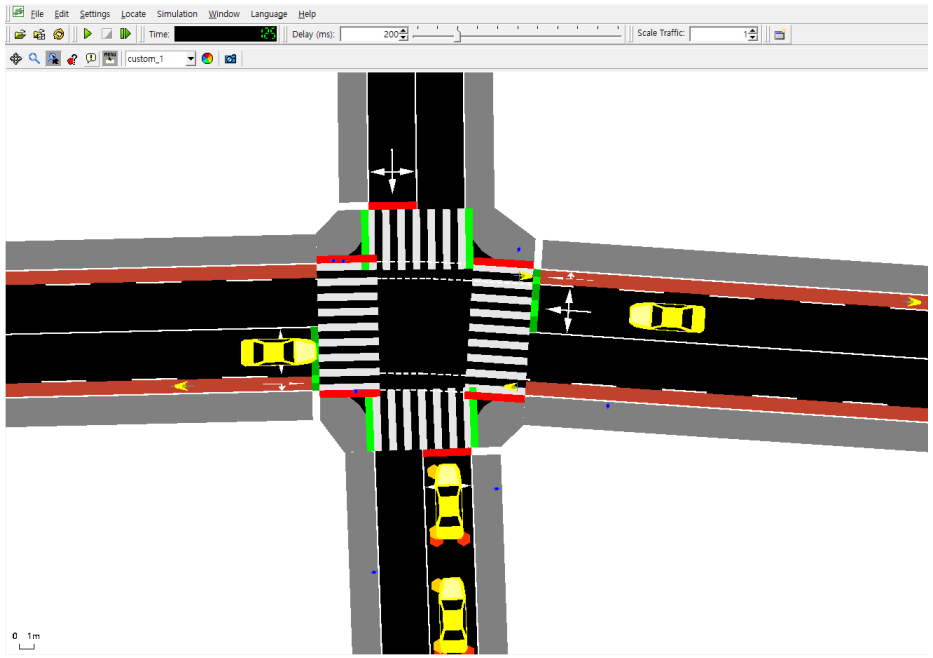


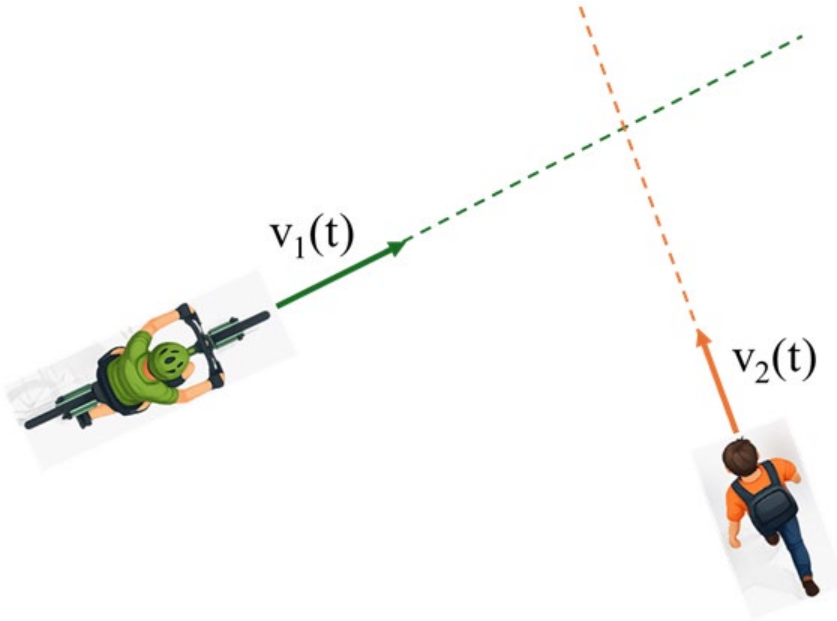
Ongoing research: Focus on bicycle accidents



交差点名称	御前通	七本松通	千本通	壬生川通	大宮通	猪熊通	関連性
実際の事故							
6区画の場合の衝突地点							○
12区画の場合の衝突地点							○
TTC							△
PET							△

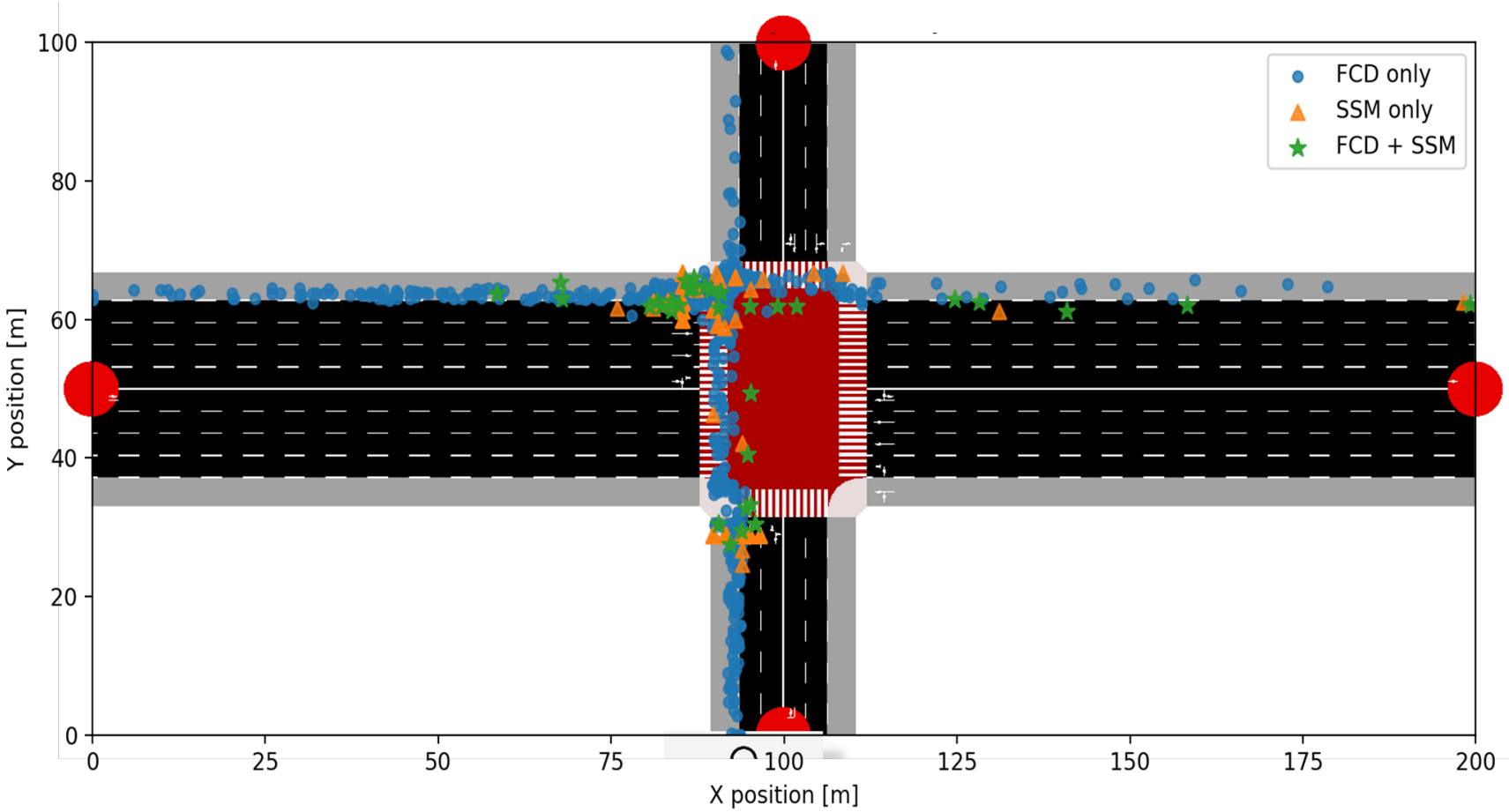
Surrogate Safety Indicator for Mixed-Agent simulation models



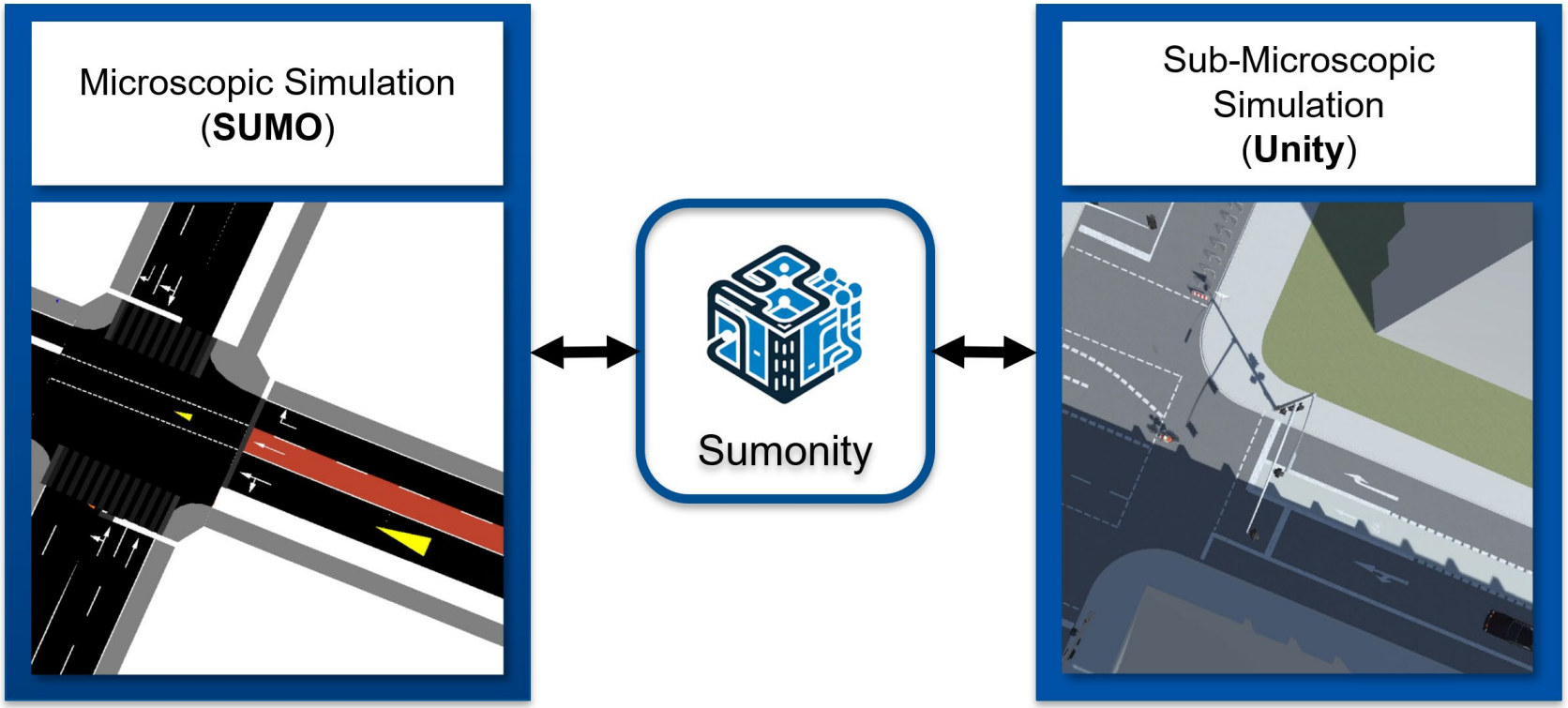


- Micro-simulating trajectories enable the inference of latent collision risk even in the absence of observed collisions.
- SSI for traffic more established than for bicycles

Conflict locations comparison: FCD, SSM



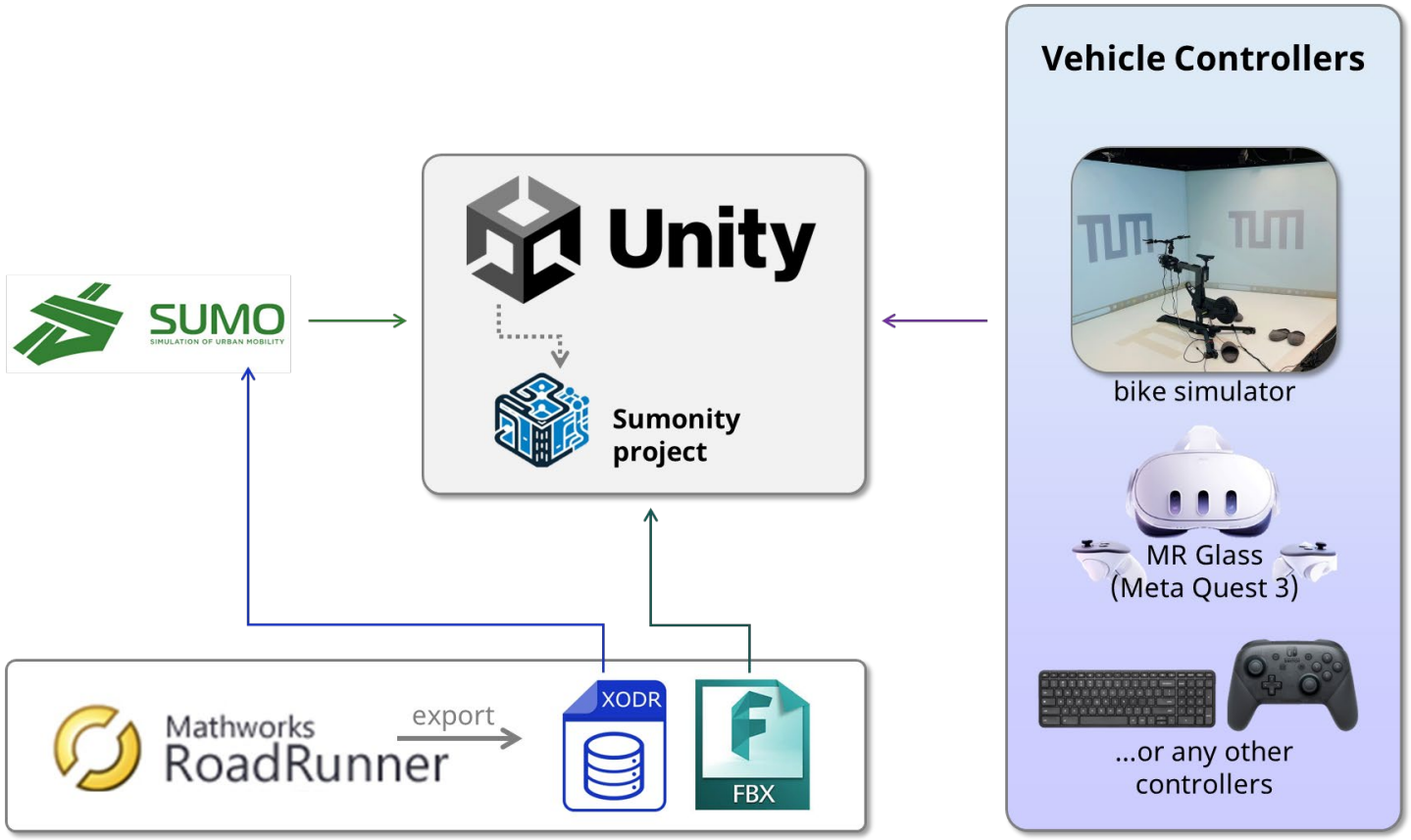
Sumonity

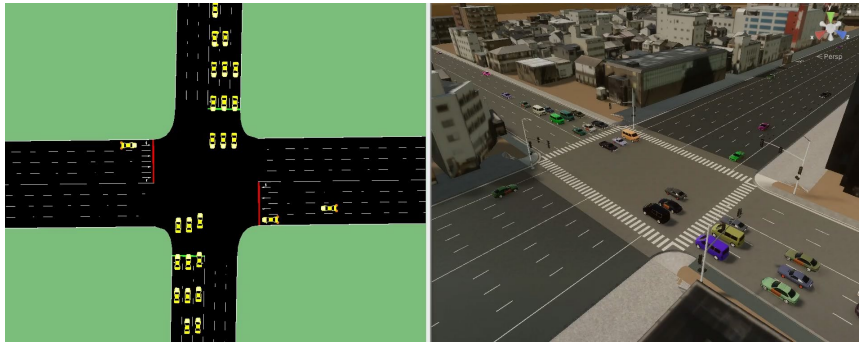


handles routing, car-following, and lane-changing

handles vehicle–e-scooter interaction, acc/dec, turning, body motion, and collisions

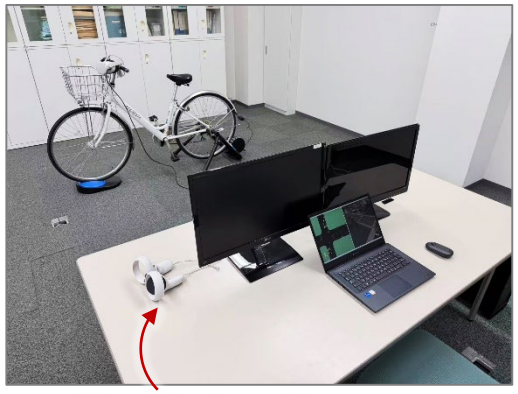
Sumonity Framework





Adding Background Vehicles/Pedestrians/Bikes/Micro-Mobilities

Bike simulator



Simulation System

Path Sensor

Speed Sensor and the Resistance

Evaluation of scenarios via feedback from participants as well as SUMO output measures:

- observed flow differences
- safety surrogate measures such as "time to collision“

“Conclusions” and discussion

- Role of POIs, in particularly restaurants, convenience stores and supermarkets at junction vicinity discussed, controlling as much as possible for “liveliness”: Planning implications?
- Importance of field of view can be quantified through number of corner cuts
- Analysis of 2-wheeler accidents deserve specific attention and require additional tools: SSM definition and SUMONITY as tool for collaborative research