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Simulation of human behavior in architectural practice. A model of pedestrian‘s movement: a case study

Dissertation Objectives, Methodology and Exemplar Case Study

5th - 6th of October 2023

- Introduction
- Problem & Motivation
- Research Question & Objective
- Methodology
  - Case Study
- Conclusion & References

Human behavior in space

relation

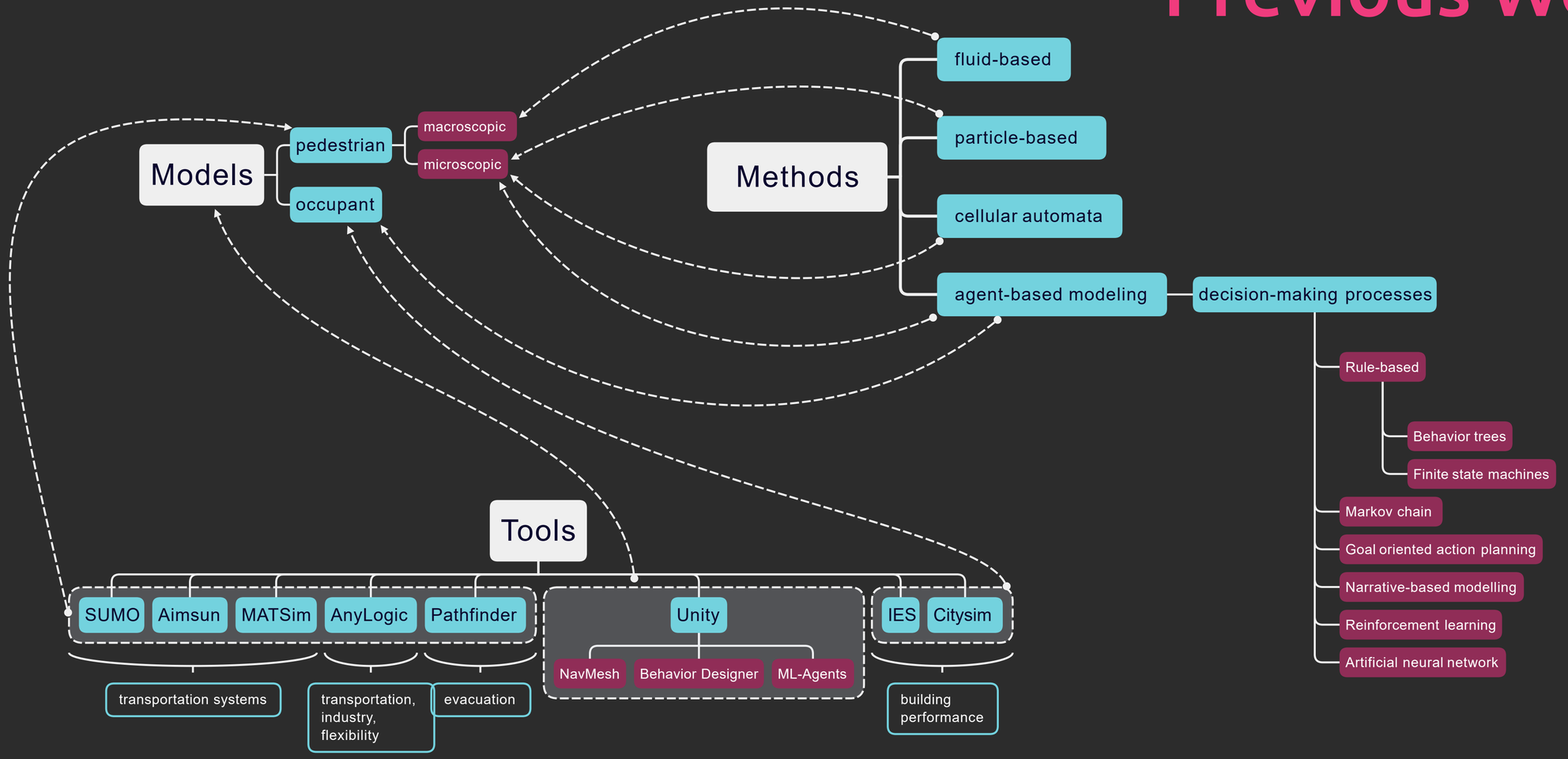
starting point of architectural and urban planning

Physical environment

Why simulation?

Image from: www.pexels.com

Previous Work



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Next Steps?

- Development of an agent-based simulation model
- Evaluation of model accuracy
- Examining practicing architects' attitudes toward experimenting with the simulation model
- Defining optimal simulation tool properties, ideal output formats and user interface requirements
- ...

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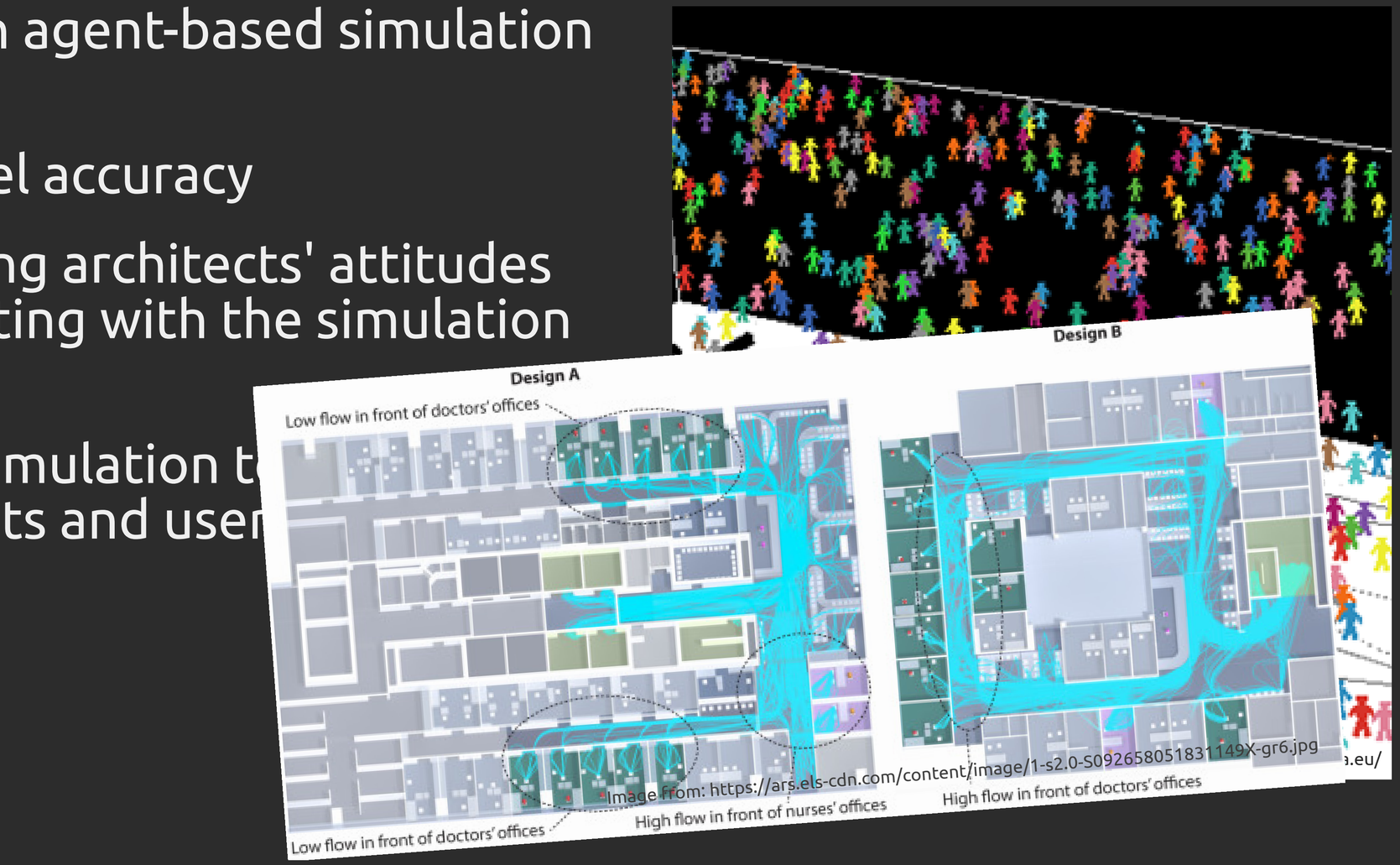

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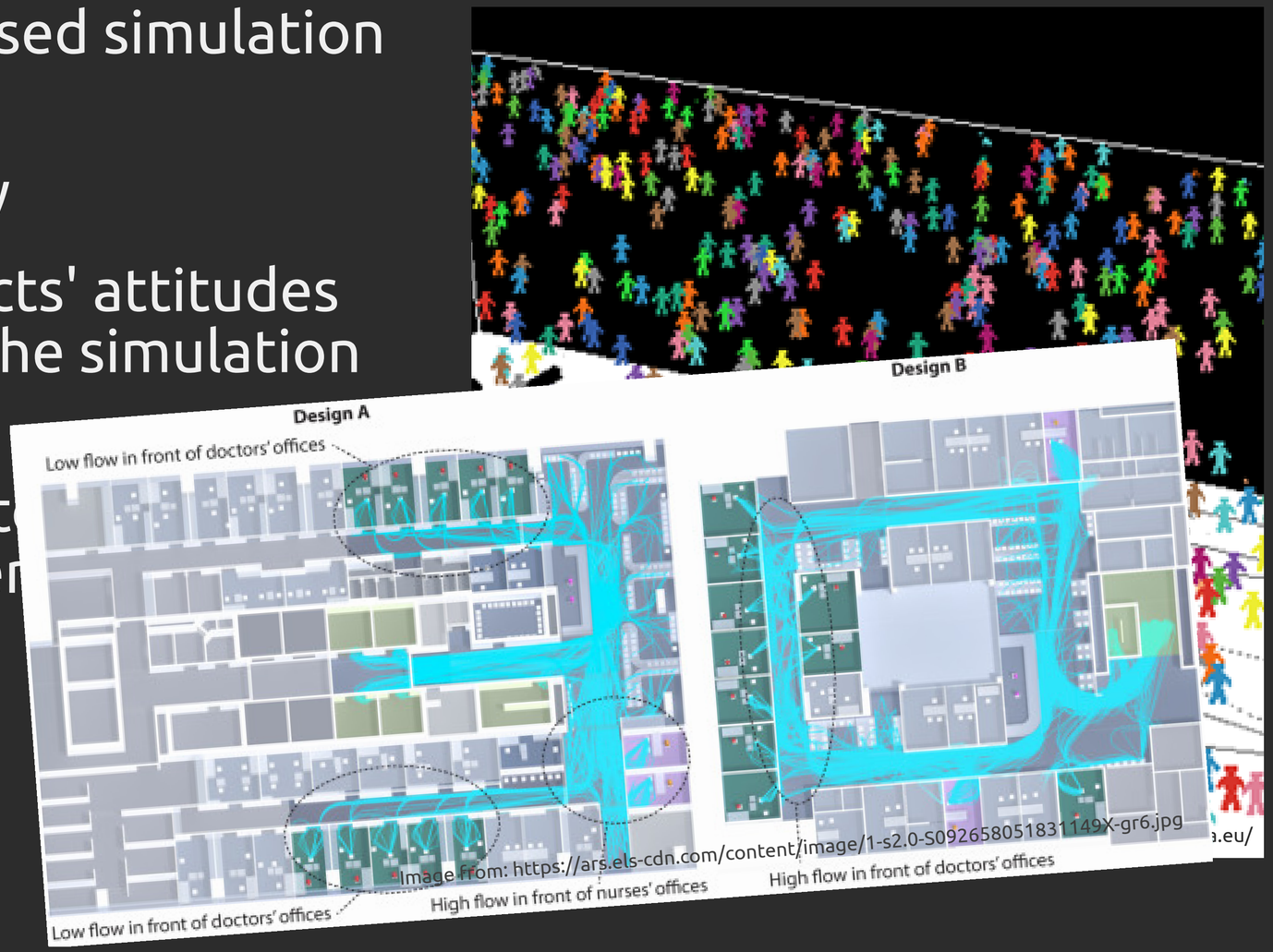
Image from: https://www.researchgate.net/publication/360186298_Latency_Analysis_of_Vehicle-to-Pedestrian_C-V2X_Communications_at_Urban_Street_Intersections/figures?lo=1



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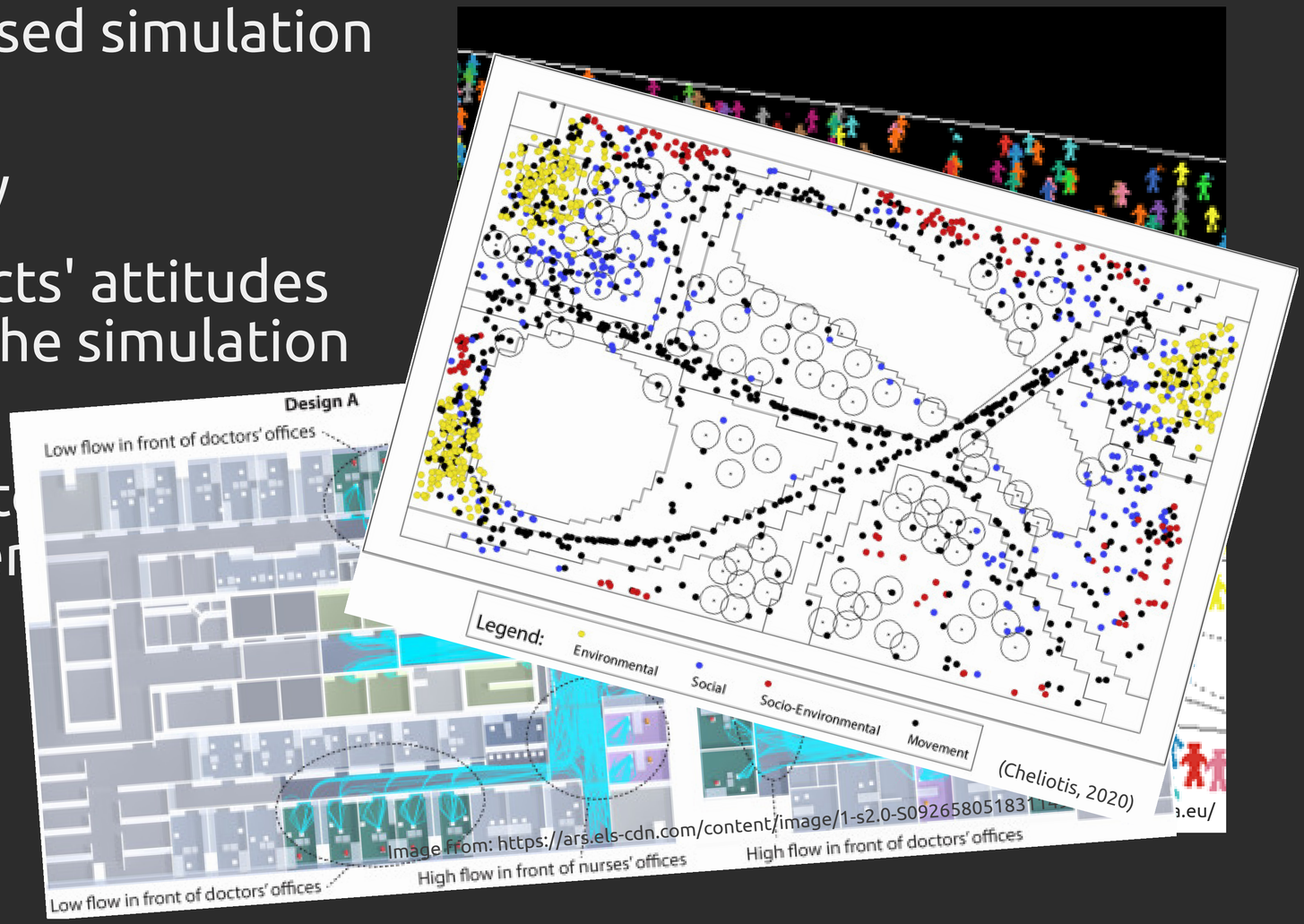

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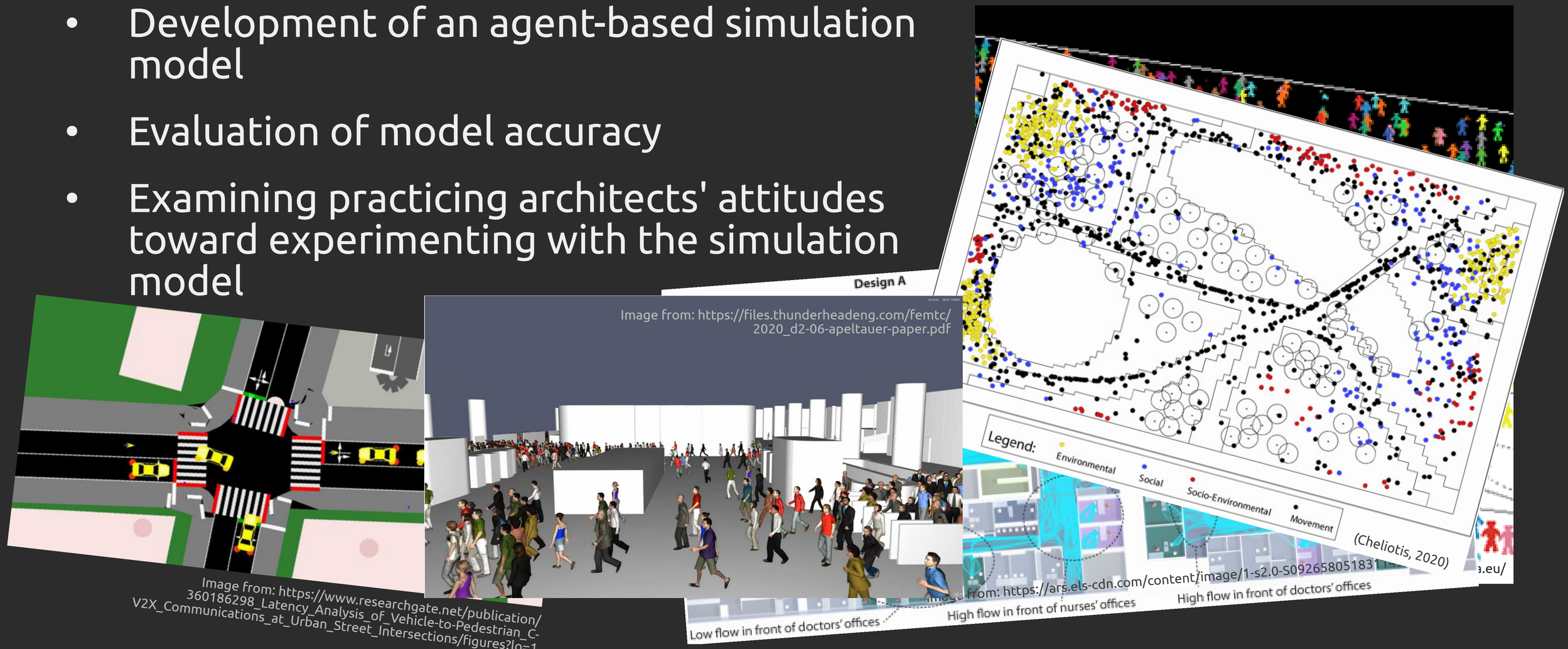

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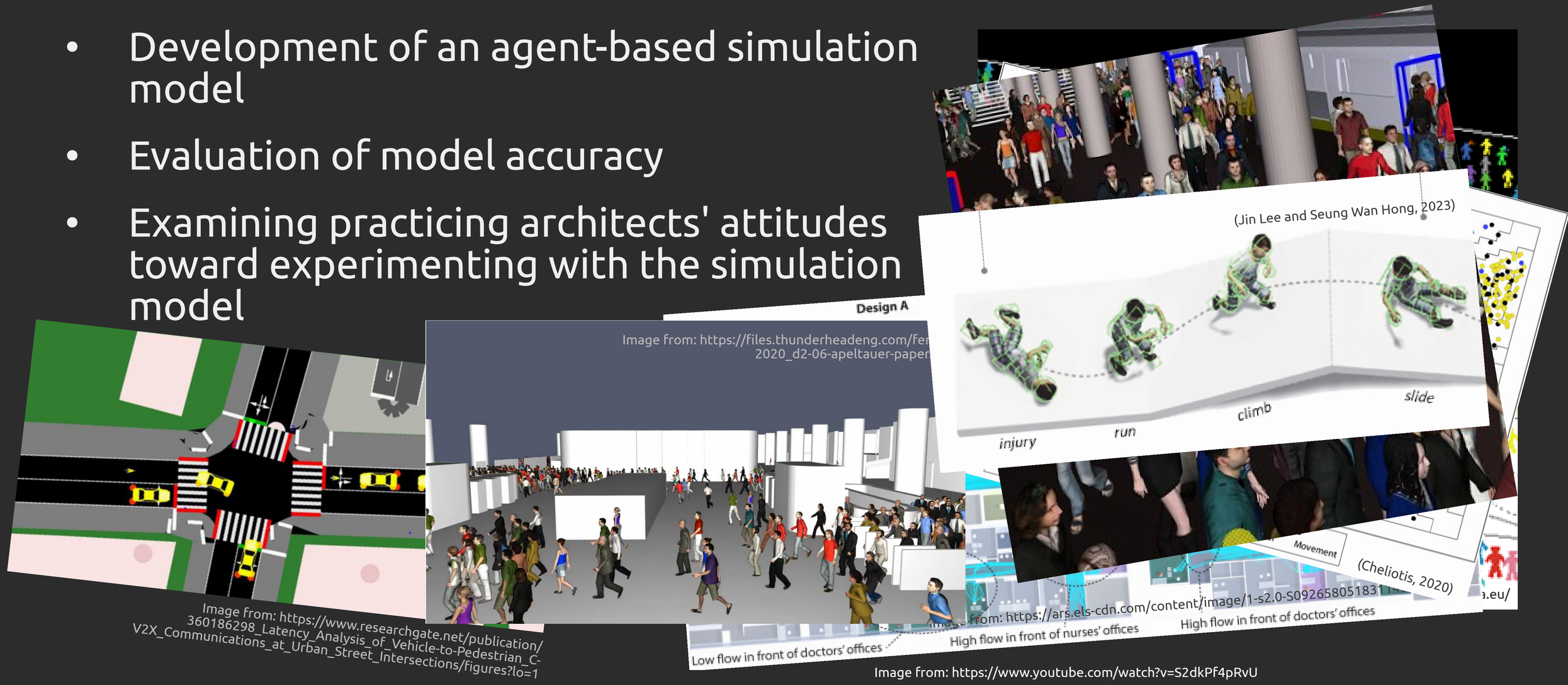

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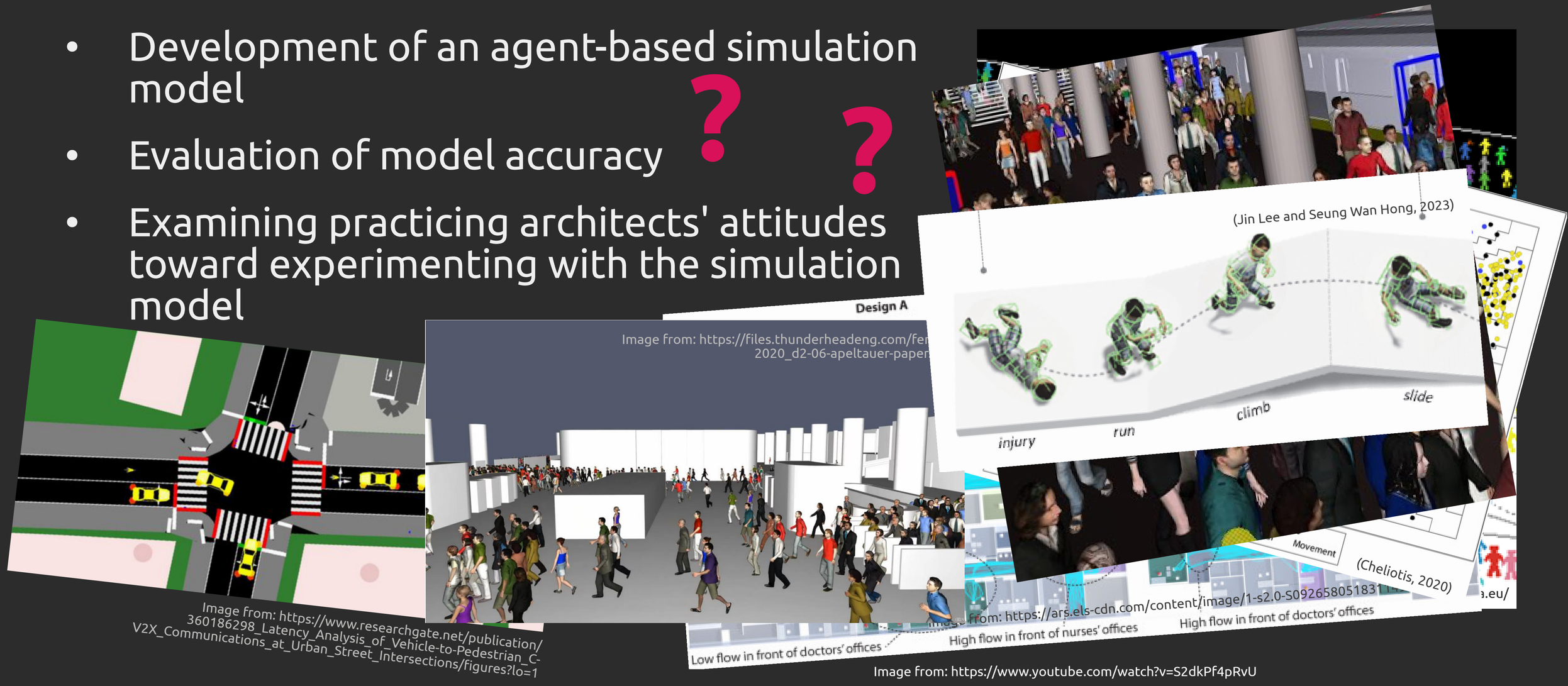

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Problem

Human behavior in proposed space cannot be explored during the design process, but only after built.

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Existing tools for simulation of human behavior have NOT been adopted in standard studios

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Motivation

Appropriate simulation can help architects with decision-making during design process

Problem

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Existing tools for simulation of human behavior have not been adopted in standard studios

WHY ?

- Lack of awareness
  - current capabilities and potential benefits
  - how to work with the available tools
- No available appropriate tools
  - integration with commonly used architectural software
  - functionality - focus on traffic, evacuation, building performance
  - price
  - learning path
- Complex process of model development
  - time & resources consuming

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Research Question

What factors influence the integration of human behavior simulation tools in contemporary architectural practice in the Czech Republic?

Objective

- **Analysis of the current state within the architectural community in the Czech Republic concerning the utilization of human behavior simulation tools:**
  - Familiarity
  - Current usage
  - Motivation to further exploration
  - Preferences & requirements for an ideal simulation tool

How?

1. Case Study
2. Tool Presentation
3. Comparative Analysis of Tools
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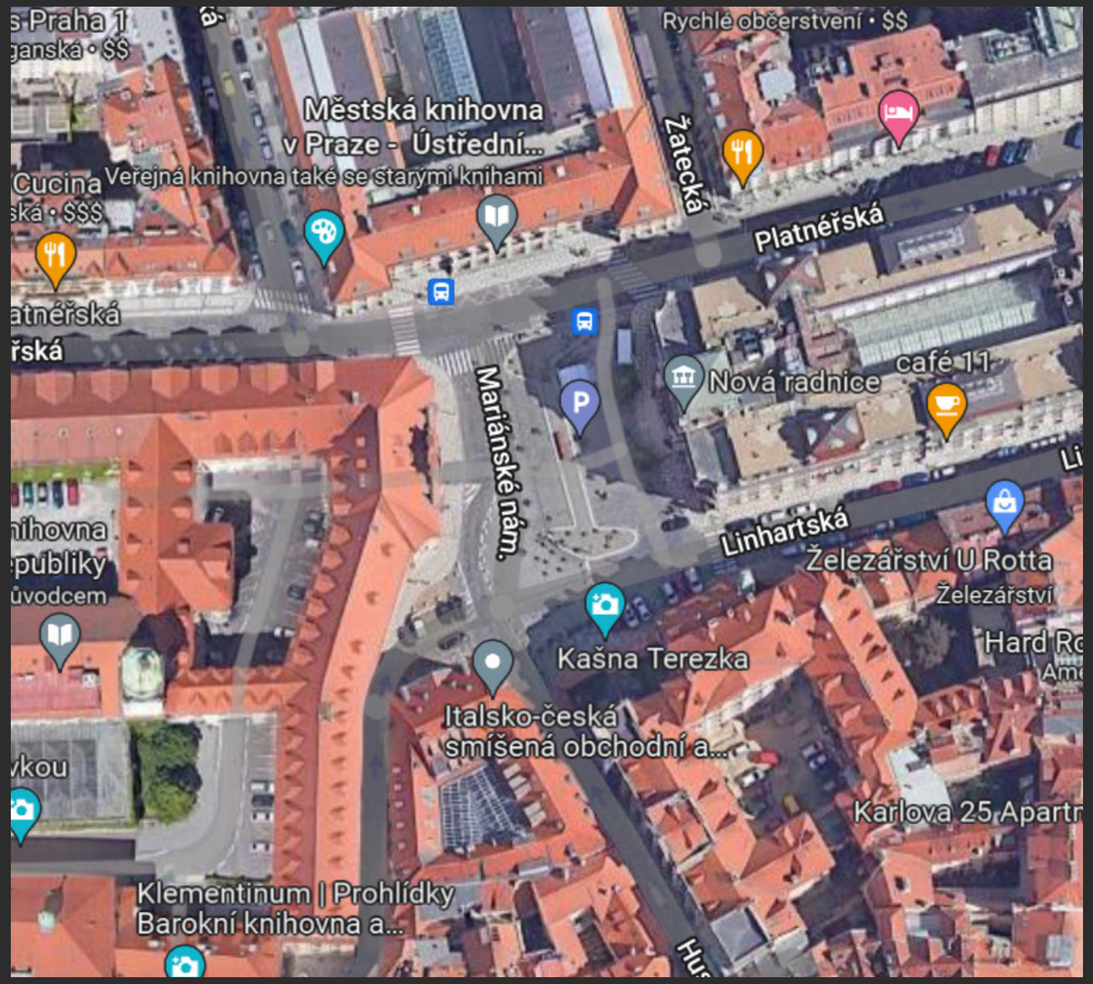
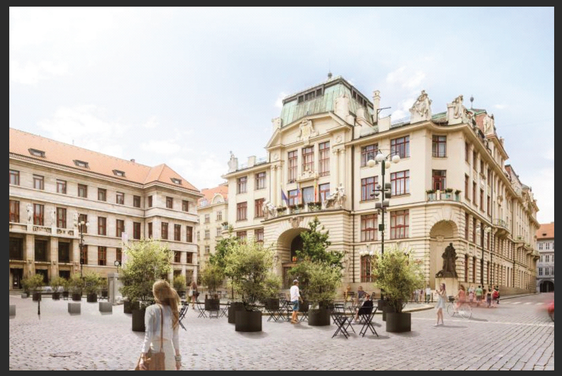
- Location: Mariánské Náměstí
- Data Resource: Behavioral analysis of public space based on a camera system
  - NCC CAI Internal workshop 2022 (TN01000024/1.f2)
- Tools: Rhinoceros, Grasshopper, PedSim
- Objective: recreate the real scenario observed in the square

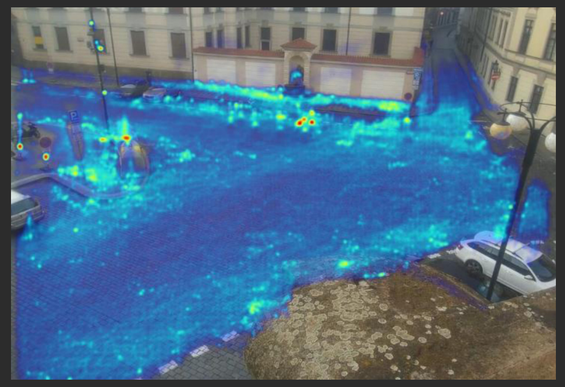
Case Study Data

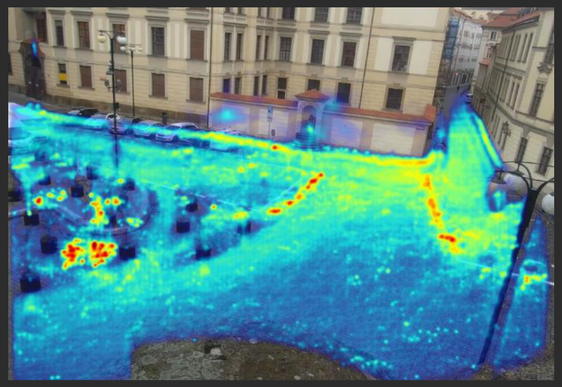




before the redesign

after the redesign





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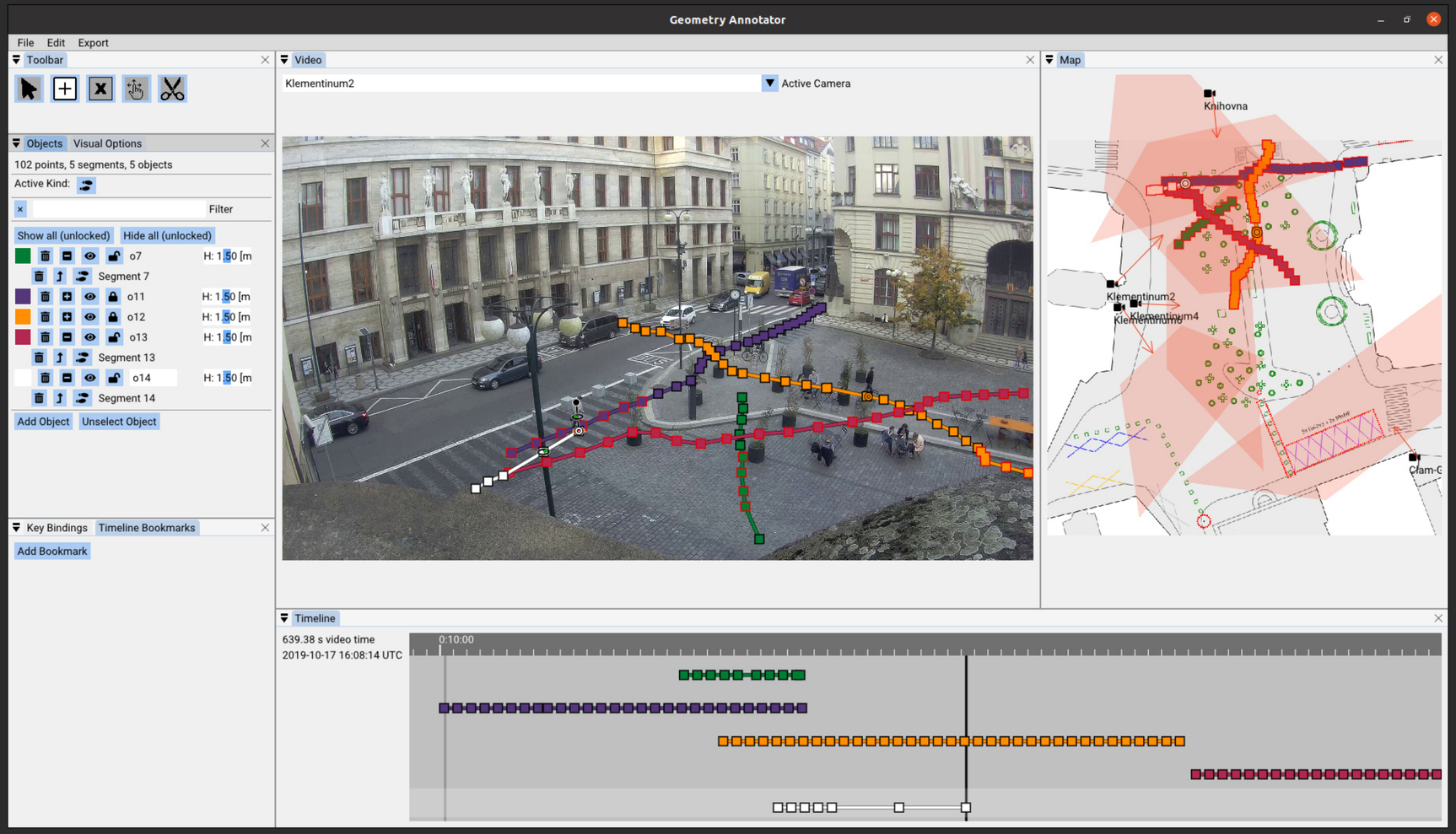

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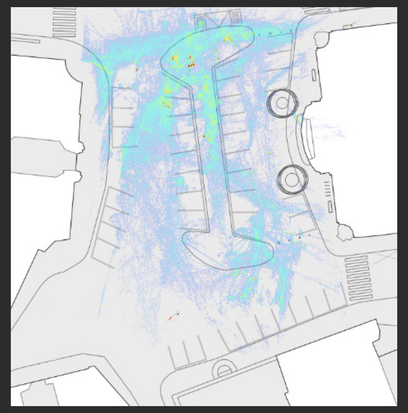

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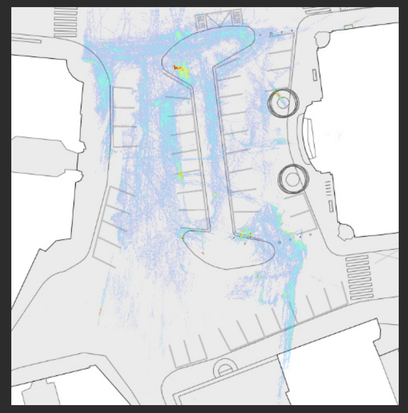

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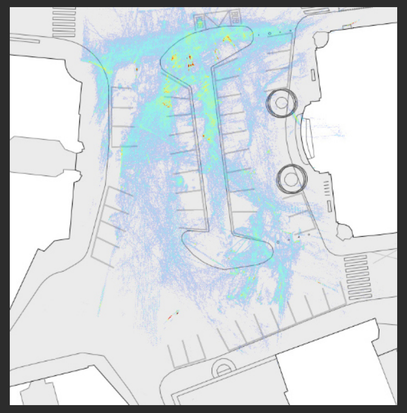

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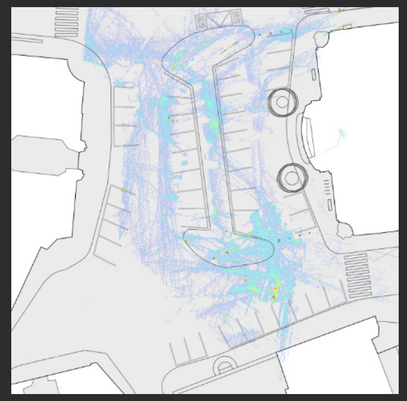

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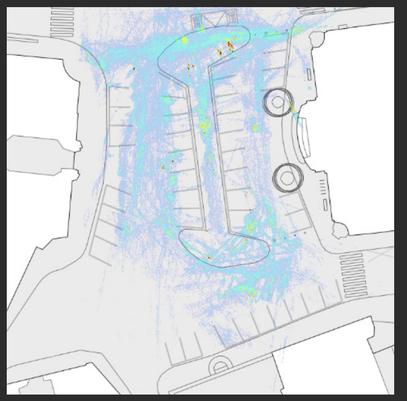

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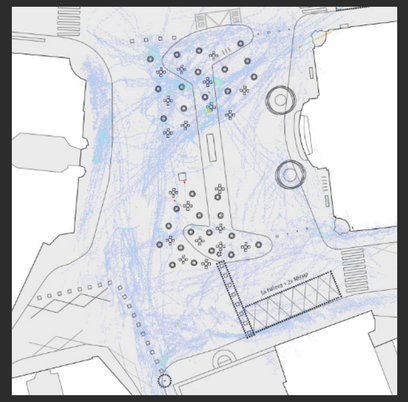
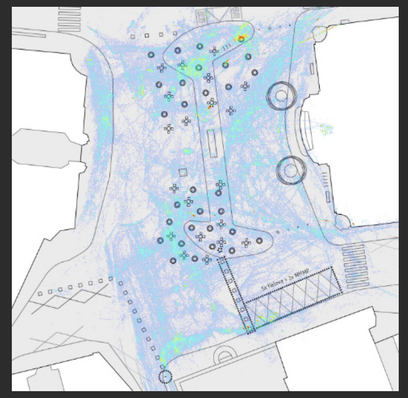
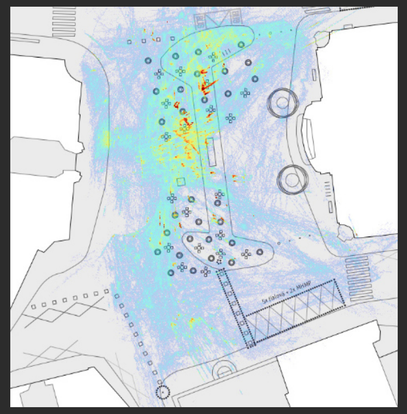
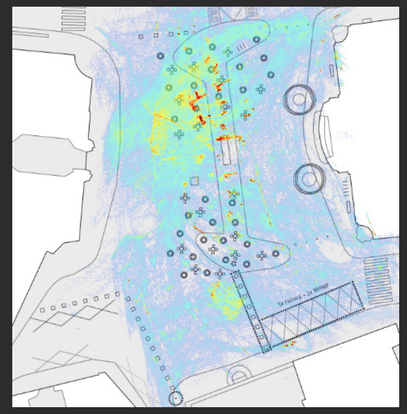
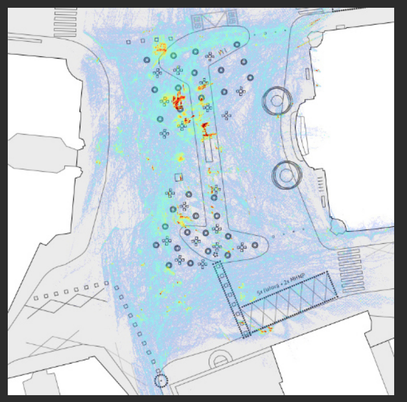




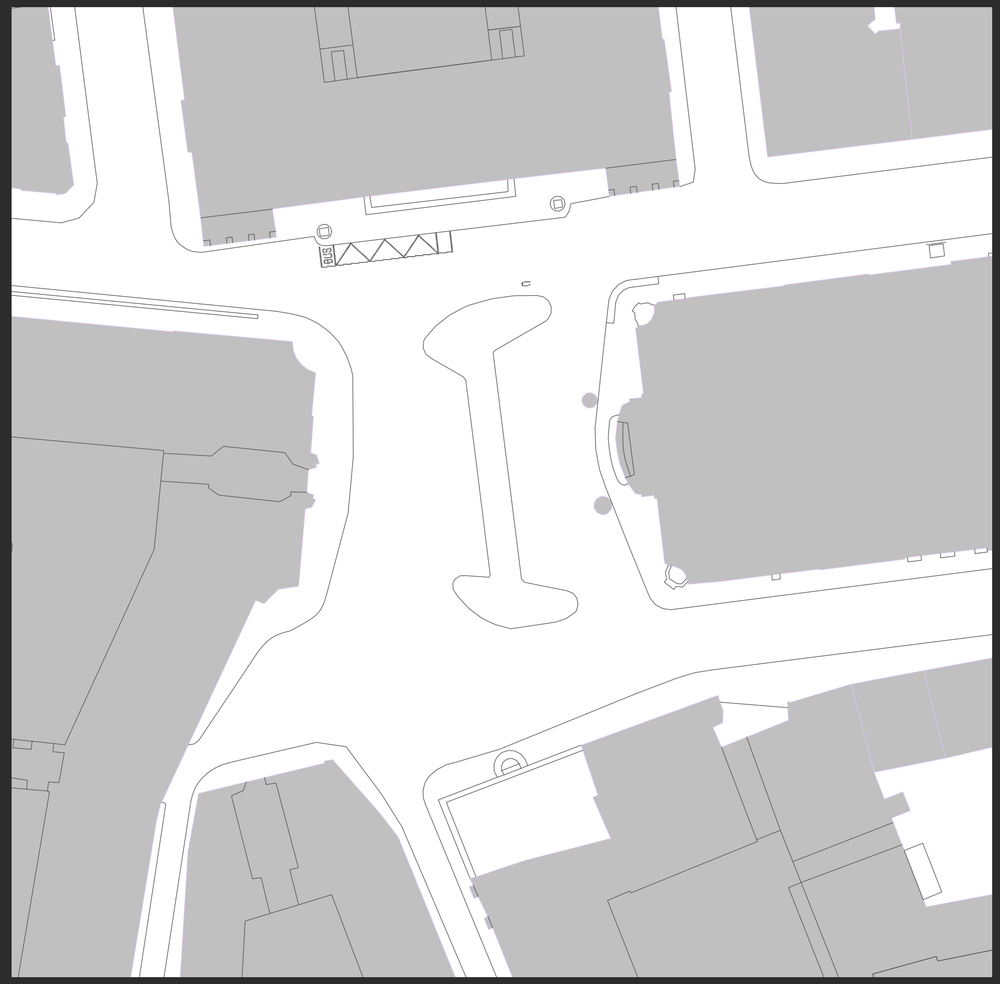






Case Study Development

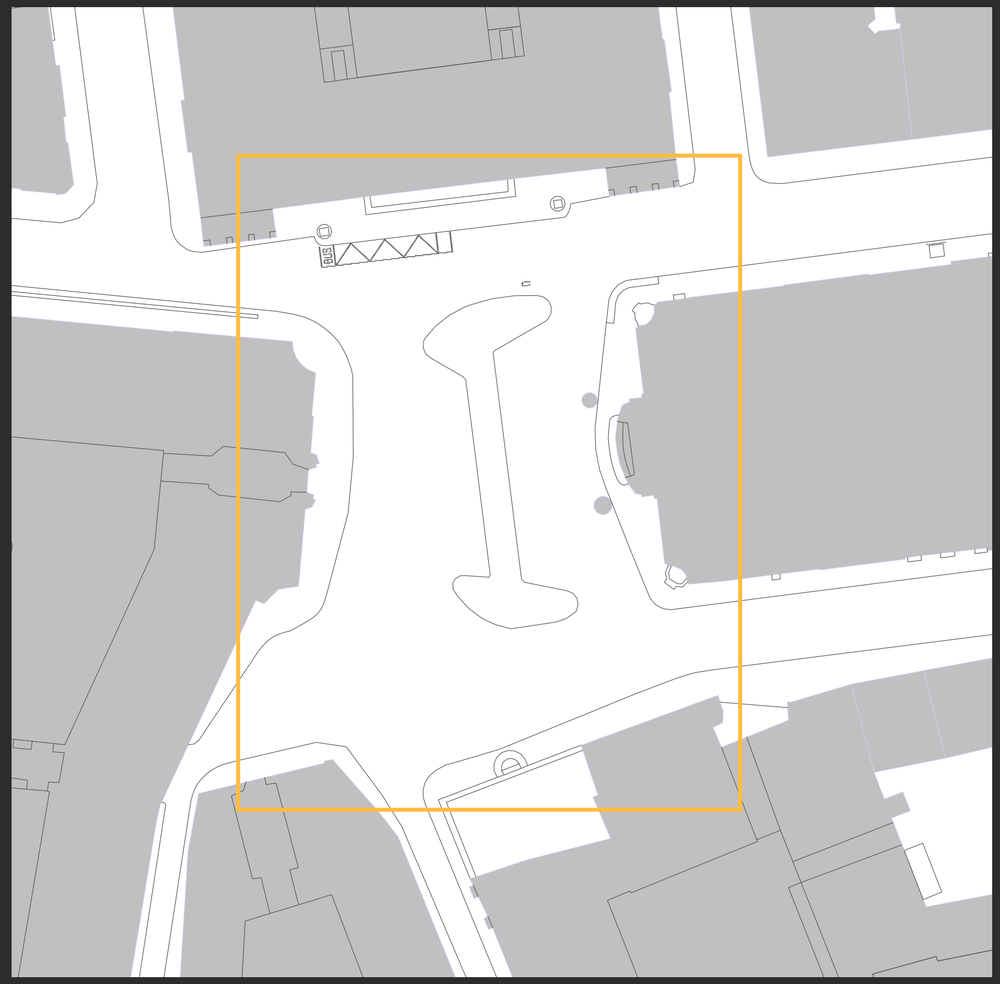
Geometry Inputs



Case Study Development

Geometry Inputs

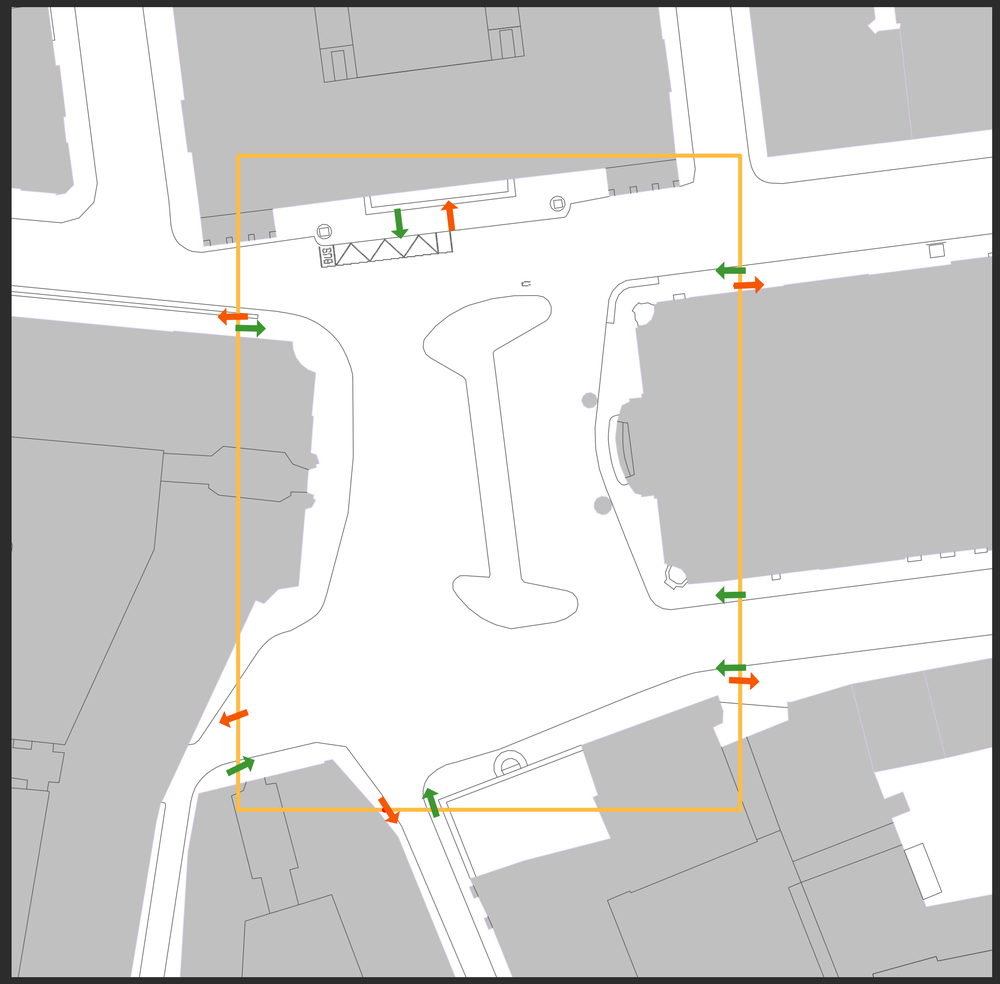
- A rectangle bounding the scene



Case Study Development

Geometry Inputs

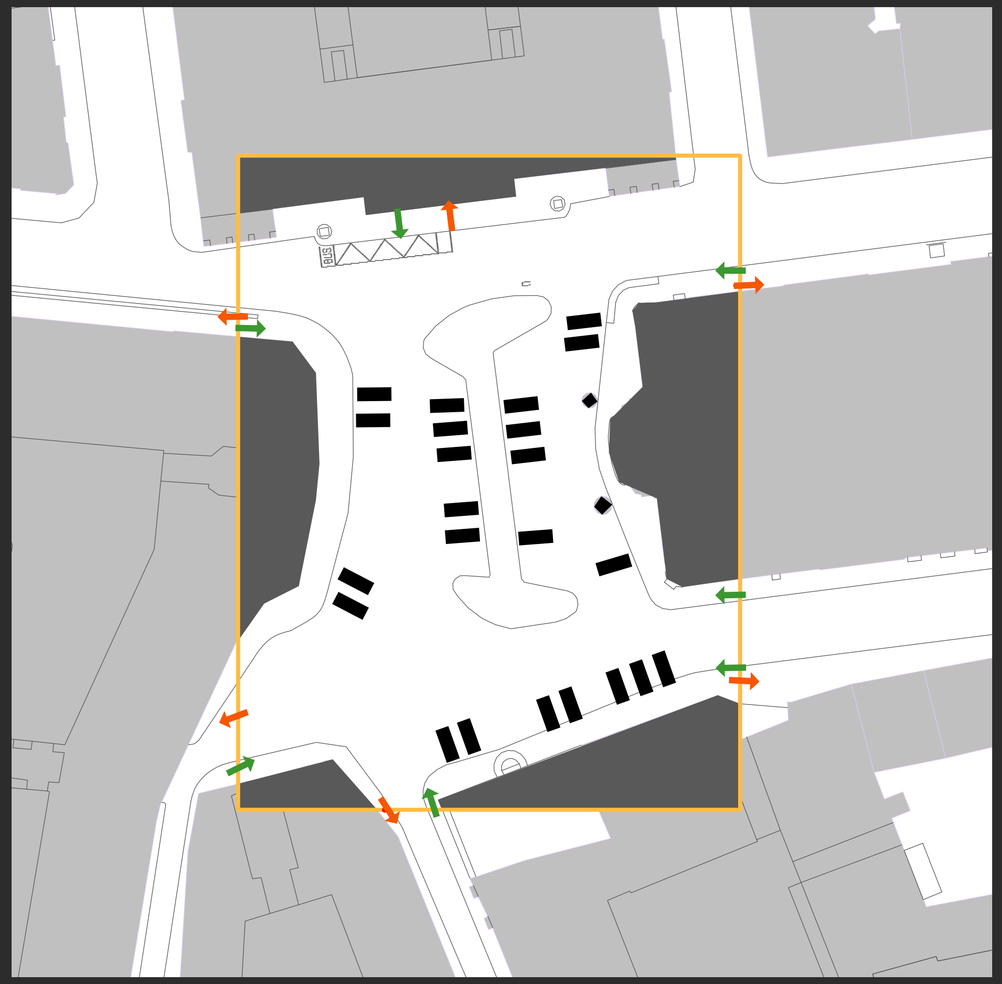
- A rectangle bounding the scene
- Points representing entrance and exit gates to the scene



Case Study Development

Geometry Inputs

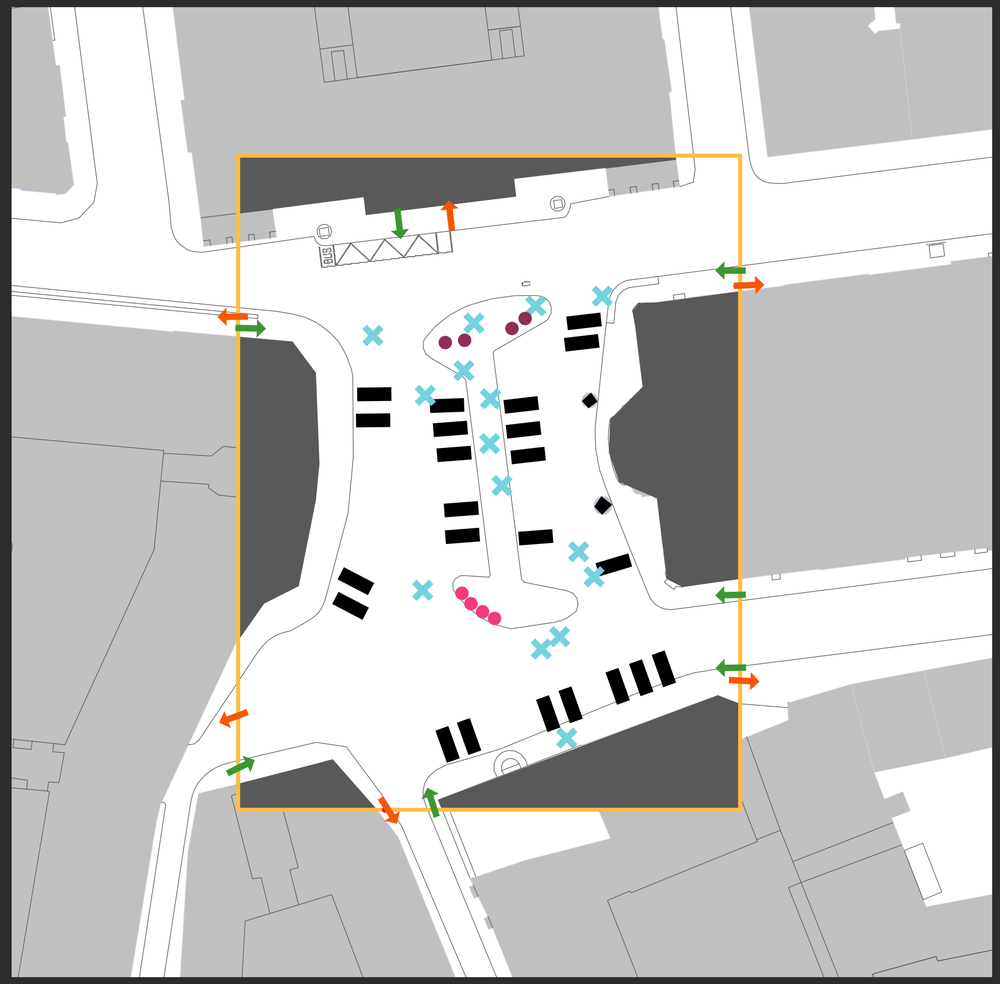
- A rectangle bounding the scene
- Points representing entrance and exit gates to the scene
- Polygons representing obstacles within the scene



Case Study Development

Geometry Inputs

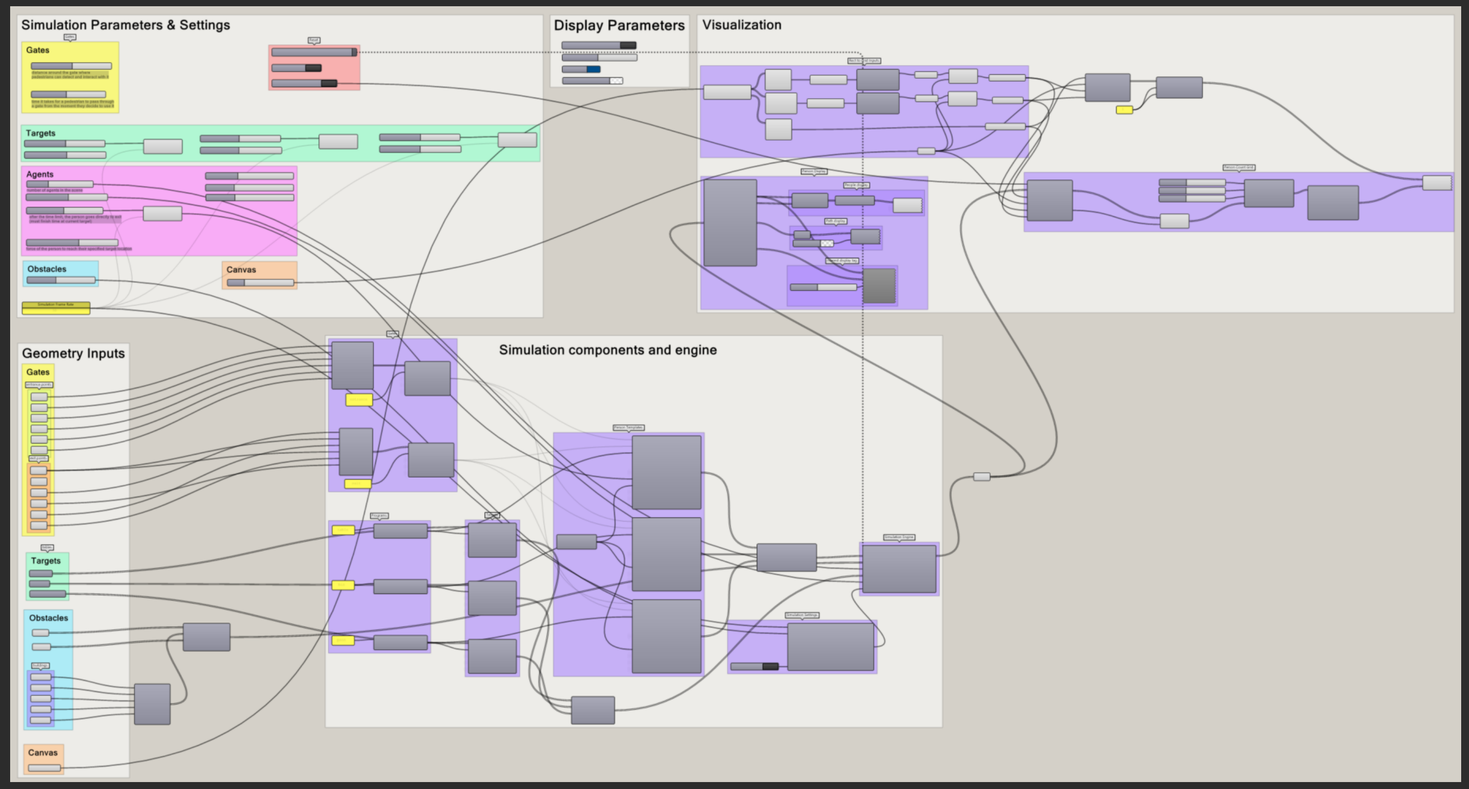
- A rectangle bounding the scene
- Points representing entrance and exit gates to the scene
- Polygons representing obstacles within the scene
- Points designating the targets, indicating a stationary activity or a passing point



Case Study Development

Script Sections

- Geometry inputs
- Simulation parameters and settings
- Simulation components and engine
- Display parameters
- Visualization



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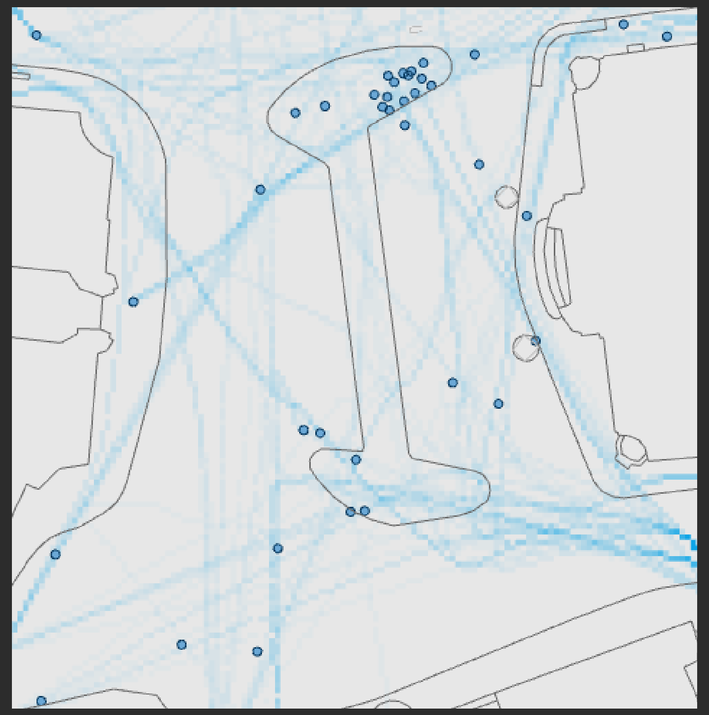
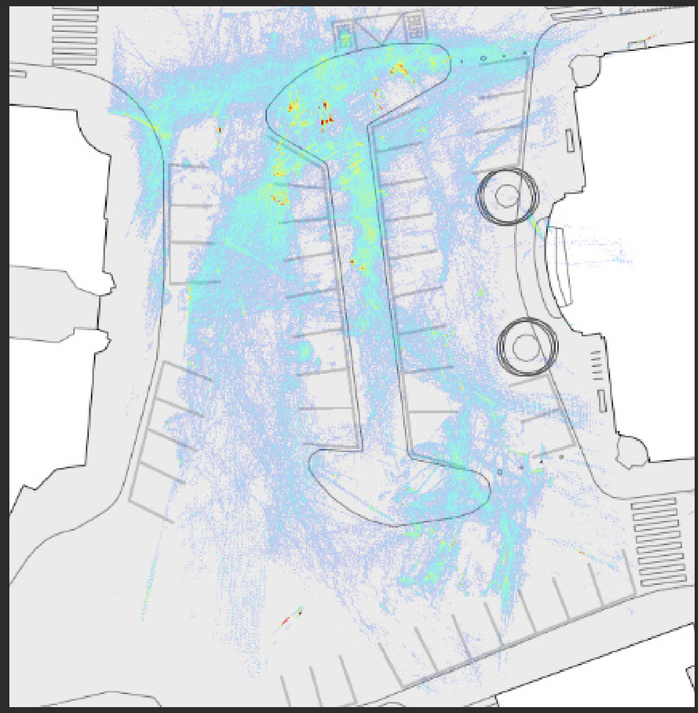
Category	Item	unit
Gates	Gate Access Radius	m
	Gate Exit Time	sec
Targets	Target Access Radius	m
	Target Visiting Time	sec
Obstacles	Obstacle Offset	m
Canvas	Cell Size	m
Agents	Population Count	person
	Person Generation Time	sec
	Person Time Limit	sec
	Target Force	-
	Target Probability	%
Simulation Settings	Frame Rate	-

Case Study Development

Simulation Outcome



Real world data outcome



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- Short video presentations introducing each of the tested simulation tools
- Demo files that allow easy exploration and interaction with the running simulations, enhancing architects' understanding of the tools

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- Analyze and compare aspects of the tested simulation tools
  - Geometry inputs
  - Parameters and simulation settings
  - Performance metrics
  - Simulation results
- Organize the comparative results in a table for clear presentation

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- Sections
  - Familiarity with simulation tools and methods
  - Current utilization and reasons for usage, including an assessment of features and functionalities if applicable
  - Motivation to learn more about simulation tools, including their interest in further exploration

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- Share the tool presentations and demo files with architects who express interest in learning more
- Consider organizing workshops to provide hands-on experience with a selected simulation tool

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- Distribute semi-structured questionnaires to architects who have interacted with the tools
- Collect feedback on tools perceptions, their overall usefulness, identification of missing and annoying features, and suggestions for improvements

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- Formulate development recommendations for the enhancement of tools
- Explore the possibility of creating a mockup of an optimized tool
- Compare the findings in Czechia with global practices

Thank you

Cyprianová, L. and Kurilla, L. (2023) ‘Simulation of Human Behavior as an Auxiliary Design Tool’, in Digital Architecture Research DARE 2023. 1st International Conference Digital Architecture Research DARe, Białystok, Poland: Oficyna Wydawnicza Politechniki Białostockiej, pp. 224–243. Available at: https://doi.org/10.24427/978-83-67185-55-4.

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