

Master's degree in Computational Social Sciences 2024-2025
Master Thesis

Modeling perceived urban insecurity: an
empirically grounded agent-based simulation

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Madrid, June 19th, 2025

WHY URBAN INSECURITY PERCEPTION?

Traditional methods are static tools:

- Miss everyday dynamics of fear
- Ignore interaction with routines & space

Perceived insecurity goes beyond crime stats:

- shaped by spatial cues, symbolic meanings & social dynamics.
- **Fearscapes** (Pain, 1997):
 - Poor lighting, visible disorder, harassment →
 - Avoidance behaviours & social fragmentation.

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WHY USING ABM?

- Simulate complex, emergent patterns from interactions between people & places
- Incorporate diverse agent behaviors
- Exploration & testing tool
- Try “what-if” scenarios (lighting, youth, routines)
- Anticipate effects of interventions (Izquierdo et al., 2020)

To capture the lived, relational nature of insecurity to move beyond crime data and reflect embodied fear

AIM & OBJECTIVES

Main purpose

Develop a simulation-based methodology to explore and test perceived urban insecurity scenarios from a spatial and data-driven perspective, for research and policy planning purposes

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Theoretical & Conceptual

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- Calibrate the model with survey-based and GIS data

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- Assess model robustness via replication and OAT sensitivity analysis
- Explore gendered and exposure-based variability

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Applicability

- Provide a flexible tool to test scenarios for researchers and policymakers

PAMPLONA AS A CASE STUDY

- Recent survey data (2023) on perceived insecurity
- Psycosocial variables (relevant according to literature review)
- Availability of crime data

INPUT DATA

.shp from
Pamplona City
Council and Open
Street Maps

Balance de
Criminalidad Q4
2024
Ministry of Interior

EMPIRICAL MODELING (R)

lightning_score
barrio
building

real_crime_proxy
Objective data (Penal
Code sentencing +
frequency) * Public perception
on most and least
safe neighborhood

road
parks

SIMULATION DESIGN (GAMA)

Environment

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Survey Data
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CATPCA

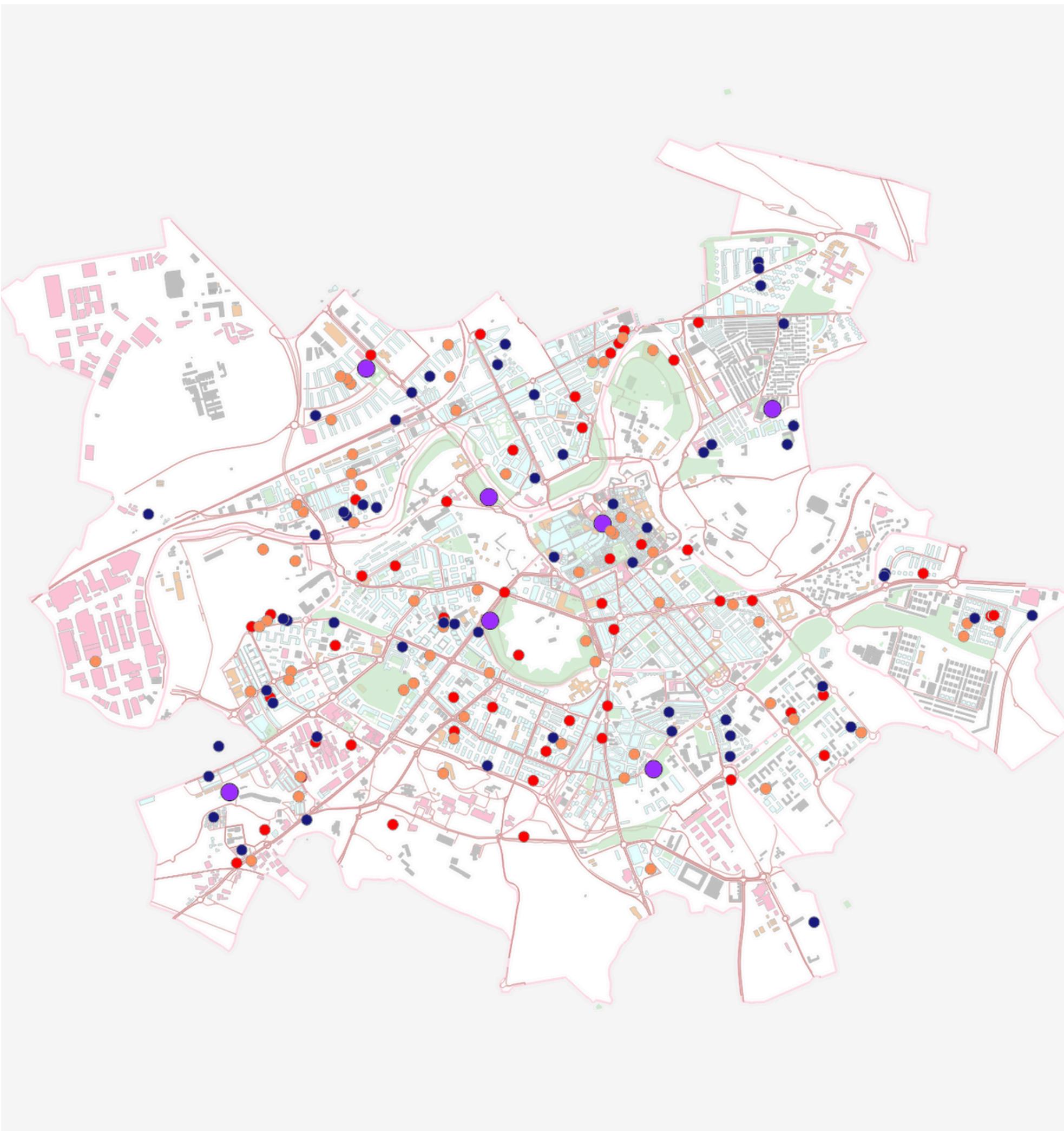
Multivariate
Linear Regression

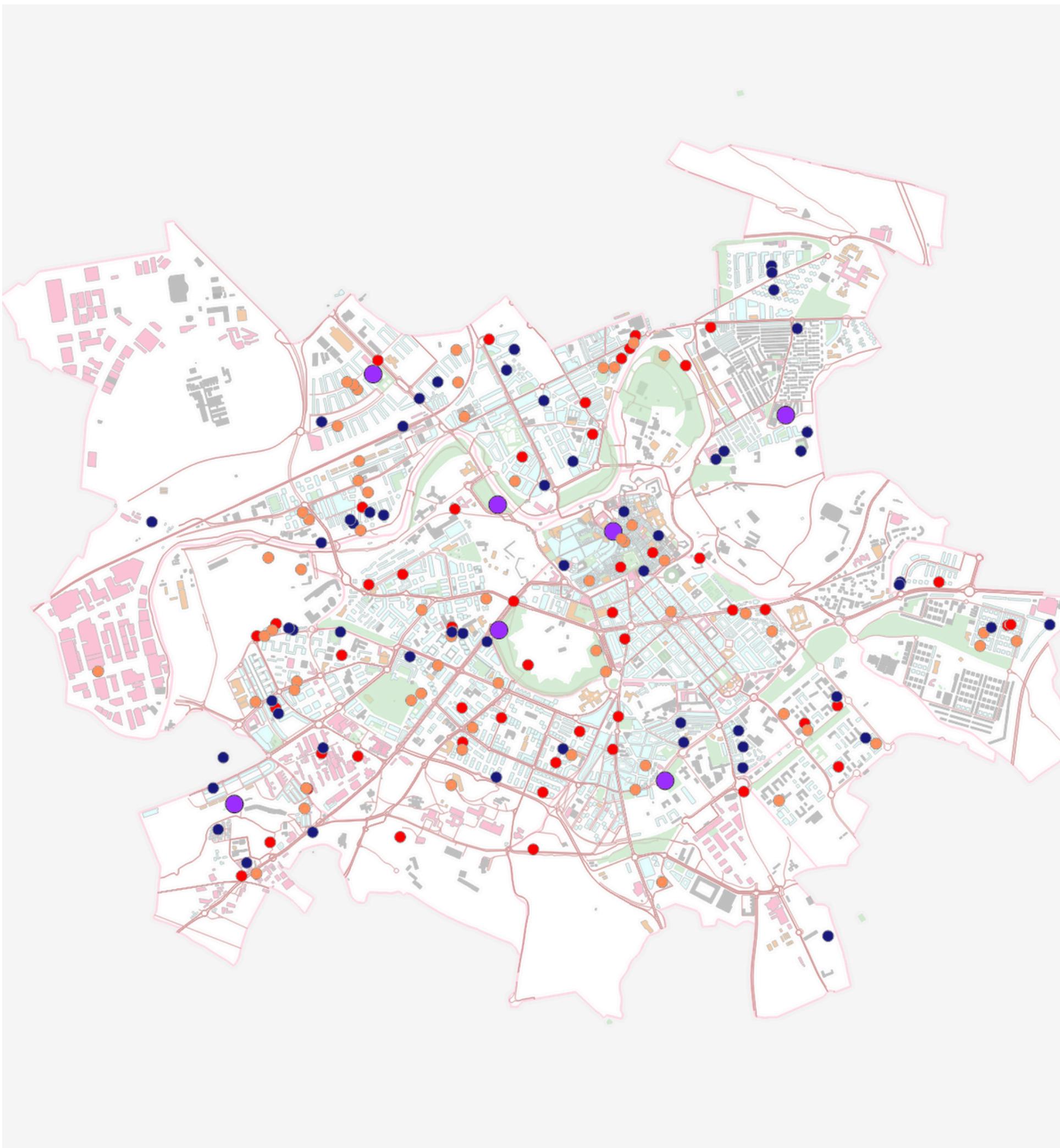
SIMULATION DESIGN (GAMA)

road
parks

Environment

Agents





- ***prediction***: linear combination
 - *gen_ins*
 - individual effects: gender, nationality, past victimization
 - social exposure: proximity to visible botellonero
 - contextual modifier (only at night):
 - *real_crime_proxy* *
 - crime_weight*
 - *darkness* * *lightning_score*

resident

Number of residents + - ↻

minimal speed + - ↻

maximal speed + - ↻

Earliest hour to start work 6 ↻

Latest hour to start work 08 ↻

Earliest hour to end work 16 ↻

Latest hour to end work 20 ↻

Threshold is insecure 01.0 ↻

Prob. leisure outside own neighborhood 0.20 ↻

GIS

botellonero

Number of botellonero groups + - ↻

Nº of days botelloneros are visible 3 ↻

contextual

Crime weight 0.5 ↻

Monitors

Number of secure people: 167

Number of insecure people: 0

resident

Number of residents: 167

minimal speed: 0.2777777777777778

maximal speed: 1.3888888888888888

Earliest hour to start work: 6

Latest hour to start work: 08

Earliest hour to end work: 16

Latest hour to end work: 20

Threshold is insecure: 01.0

Prob. leisure outside own neighborhood: 0.20

GIS

botellonero

Number of botellonero groups: 7

Nº of days botelloneros are visible: 3

contextual

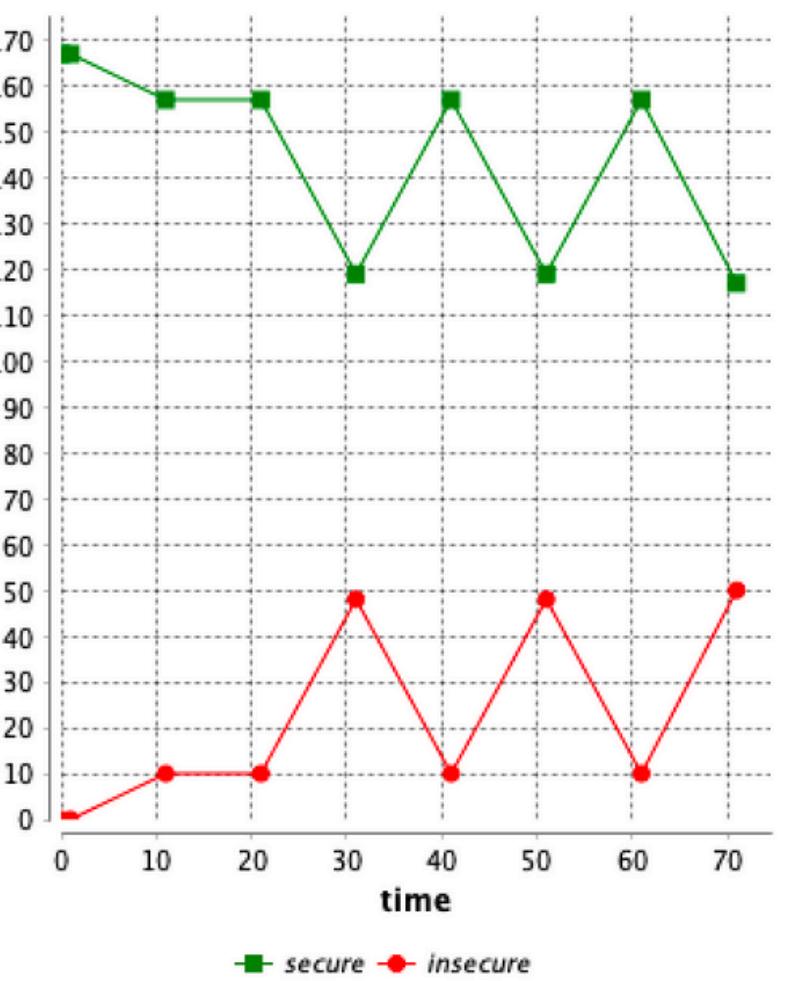
Crime weight: 0.5

Monitors

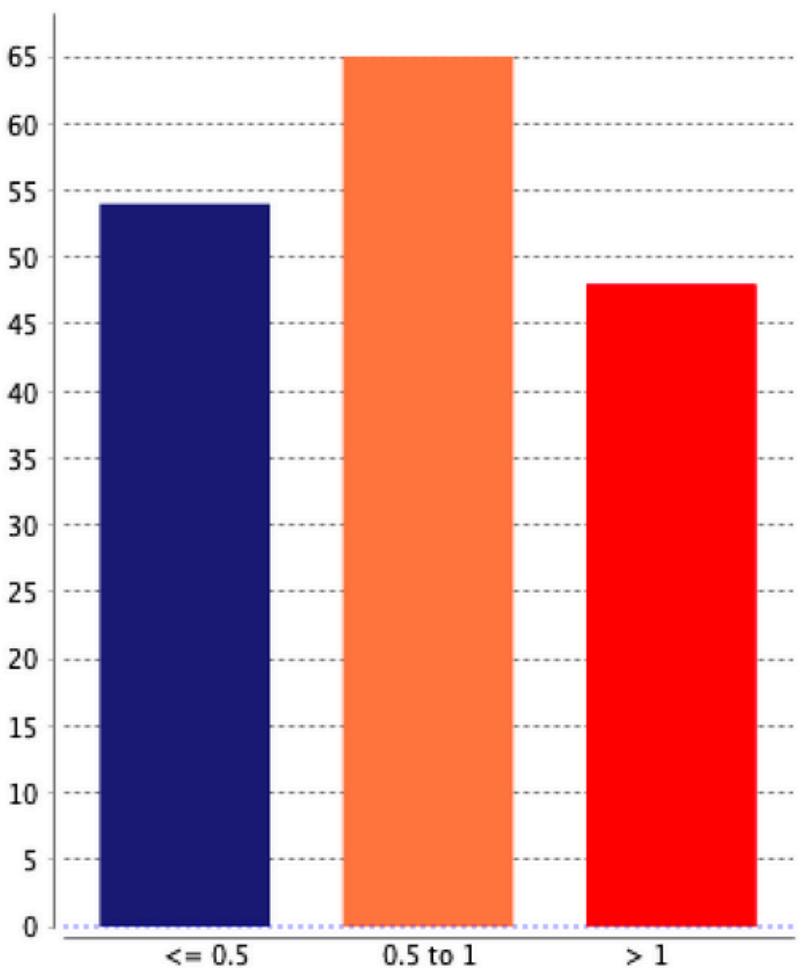
Number of secure people: 167

Number of insecure people: 0

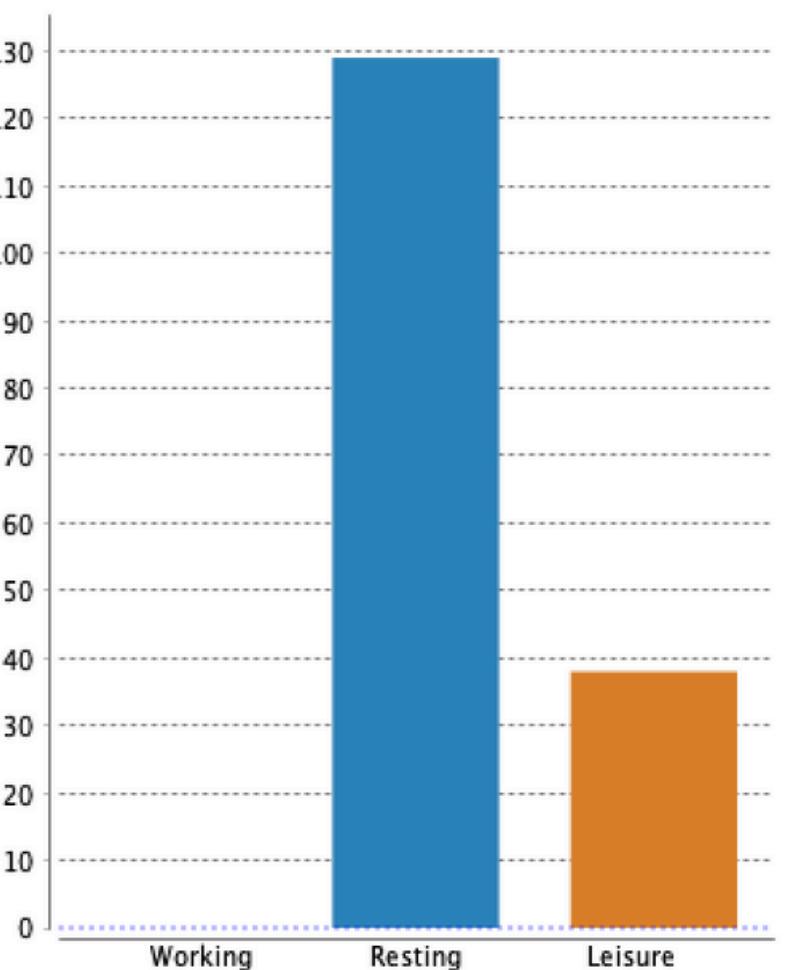
Residents classified as insecure (threshold-based)



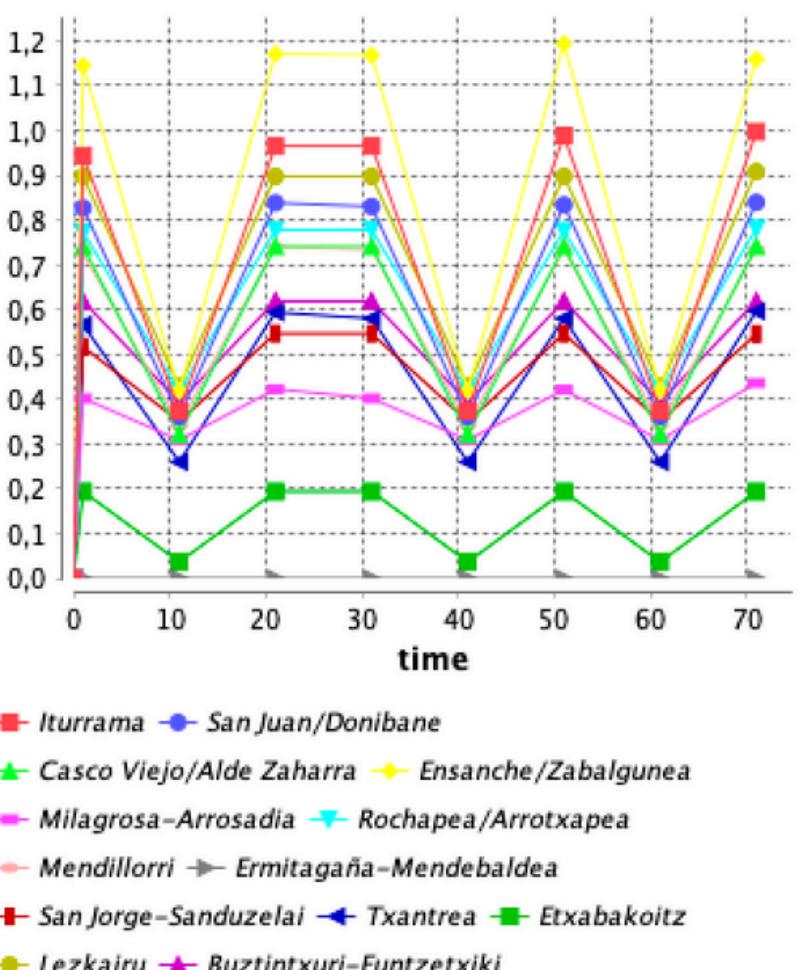
Distribution of residents depending on safety level



Resident objectif



Mean prediction by barrio



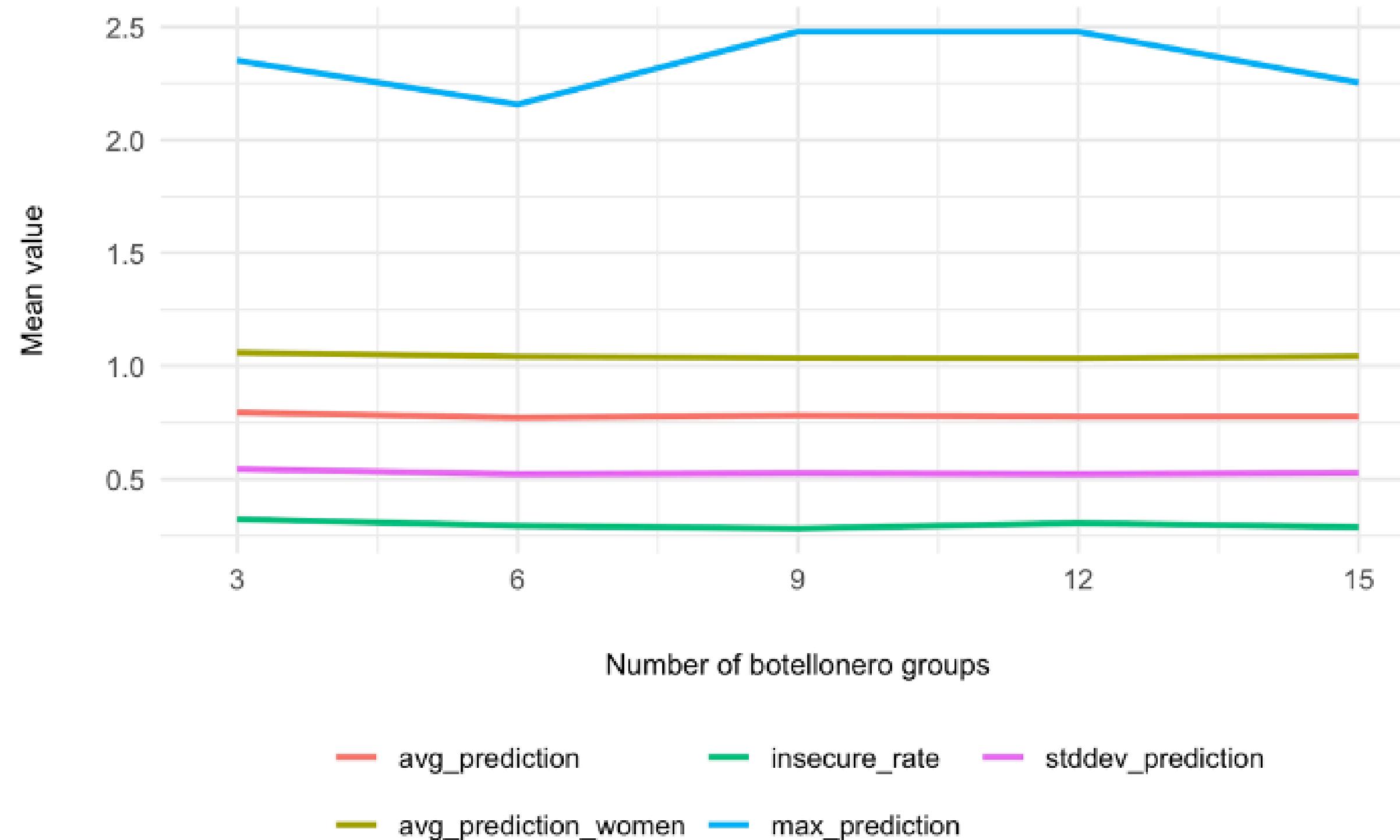
SIMULATIONS FOR DECISION-MAKING (I)

It's Friday night. Small groups of young people gather around different squares.

At first, people pass by without issue, but for some residents this triggers discomfort.

The city wonders: are these feelings of fear significant enough to plan around?

SIMULATIONS FOR DECISION MAKING (I)



SIMULATIONS FOR DECISION-MAKING (II)



SANFERMINES



SIMULATIONS FOR DECISION-MAKING (II): SANFERMINES

- Shift in urban dynamics
- Disrupts everyday routines & exposure patterns
- Alters symbolic meaning and perceived safety of public space
- Policy question: *for whom does insecurity increase?*

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What would be needed?

- Adjust leisure & mobility parameters
- Model temporary urban layouts
- Include crowding and time-specific risks

TO SUM UP...

MODEL CONTRIBUTIONS

- Challenges purely criminological approaches of insecurity
- Improves on prior models (e.g., Izquierdo et al., 2020):
 - Adds agent heterogeneity (gender, vulnerability, nationality)
 - Includes temporal context
- Demonstrates internal coherence, empirical plausibility, and theoretical consistency

FUTURE IMPROVEMENTS

However, there are some **LIMITATIONS**

- No interaction effects between different variables



that can be **ASSESSED** with

- Robust global sensitivity analysis methods, such as Sobol indices or Latin Hypercube Sampling.

- Circularity in crime parameters



- Georeferenced crime incidents data

- Fixed routines and lack of capacity for adaptation or learning



- Feedback mechanisms (agents modify their behavior based on prior experiences)

THANK YOU VERY MUCH FOR YOUR ATTENTION

Questions or comments are welcomed!