ABM for Systemic Inequality in Policing

ODD+D Protocol

This document details the purpose of the ABM for Systemic Inequality in Policing, as well as justification for certain design choices and technical implementations. By following the established ODD+D (Overview, Design, Details, Decision) protocol, this document is intended to boost the transparency, reproducibility, and extensibility of the model.[1]

Structural elements		Guiding questions	Answer
I) Overview	I.i Purpose	I.i.a What is the purpose of the study?	The study is designed to highlight the difference between the conceptualization of systemic inequality in policing as a problem stemming from a "few bad apples" rather than systemic racism embedded in the structure of law enforcement. By illustrating how the exact conceptualization of inequality brings forth varying policy implications and impacts to communities, this study aims to delve deeper into the details of how we define and perceive systemic inequality.
		I.i.b For whom is the model designed?	The model is designed primarily for the general public to better understand the meaning of systemic inequality, but could be built upon for academic or scientific purposes to examine the impact of specific policy reforms on simulated police organizations.

[1] See https://doi.org/10.1016/j.envsoft.2013.06.003 for a detailed description of the ODD+D protocol.

	I.ii Entities, state variables and scales	I.ii.a What kinds of entities are in the model? and I.ii.b By what attributes (i.e. state variables and parameters) are these entities characterised?	*Police patches* are initialized at the center of the model, based on data from specific precincts. The size of the police department is based on the number of officers in real life, not counting civilian personnel. *Community patches* are initialized based on data from the neighborhoods served by the precinct. These data include population, population density, land area, violent crime rates, property crime rates, and civilian race. *Civilian agents* populate these neighborhoods. They are initialized with race, a memory of recent interactions with police, and a chance to commit crime based on the crime rate of their neighborhood. When not involved in a crime, civilian agents may decide to commit a violent or property crime against the nearest other agent; otherwise, they wander randomly within their neighborhood. *Police agents* populate the police department. They are initialized with individualized implicit racial biases, varying tendencies for violence, and chance of resolving a crime using excessive force against specific racial groups. When responding to a call, police agents may decide to use excessive force based on their knowledge of the neighborhood and their implicit biases. When not responding to a call, police agents wander randomly within the police department. *Police operator* is an invisible helper agent that takes calls from civilians and randomly routes them to an available police officer, maintaining a backlog of calls in case no officer is available.

I.ii.c What are the exogenous factors/drivers of the model?	The model illustrates the premise that violent, racial biases by individual police agents is the primary factor behind systemic inequality, resulting in a feedback loop that reduces community trust in police and ultimately results in more crime in black and brown communities. This is contrasted to a more complicated model wherein specific mechanisms perpetuate and exacerbate the effects of these racial biases, holding the assumption that racial biases cannot be reformed away and that it is the responsibility of policymakers to design such a system that racial bias cannot yield disproportionate results for different communities.
I.ii.d If applicable, how is space included in the model?	Space is based on comparative real-life neighborhood sizes. The police department is located at the center even though that may not necessarily be true given urban planning considerations; for the purposes of this model, having the police department be the center with neighborhoods randomly scattered around allows for ease of illustration and maximum flexibility to use seed data from other cities.
I.ii.e What are the temporal and spatial resolutions and extents of the model?	Every agent is the size of one block. The entire model spreads across 65 blocks, though this can be adjusted based on the size and number of the police precinct and neighborhoods illustrated.

	I.iii Process overview and scheduling	I.iii.a What entity does what, and in what order?	Civilian agents may decide to commit a violent or property crime against the nearest agent. The victim calls the police operator, which then dispatches a random available police agent to the victim's location. Once the police agent has arrived, they may decide whether to resolve the situation with excessive force based on their knowledge of the crime rates of the neighborhood and the perpetrator's race, along with their own racial biases and tendencies for violence. This interaction is then remembered by the agents involved and the crime rates of the neighborhood, along with general impressions of police, are impacted accordingly. The police agent returns to the police department and informs the police operator that they are once more available.
II) Design Concepts	II.i Theoretical and Empirical Background	II.i.a Which general concepts, theories or hypotheses are underlying the model's design at the system level or at the level(s) of the submodel(s) (apart from the decision model)? What is the link to complexity and the purpose of the model?	As existing research suggests that implicit bias training is less effective than other measures at reducing police brutality, the model assumes that implicit bias within police agents is immutable and instead focuses on the disproportionate impact on communities due to such bias. Nonetheless, the model largely ignores the structural problems underlying systemic inequality in policing, instead primarily illustrating the notion that a "few bad apples" have given a bad name to policing, disregarding the role of structural racism. The model also incorporates elements of legitimacy theory and the legal estrangement of communities from police institutions, illustrating a self-perpetuating cycle of mistrust in the police based on individuals' experiences with the police.

	By designing a relatively simple model without any of the important nuances involved in systemic inequality, the model aims to illustrate the "bad apples" model fairly and acknowledge that while it is a valid hypothetical concept that does result in disparate outcomes, it still does not accurately encapsulate the systemic factors seen in real-life policing.
II.i.b On what assumptions is/are the agents' decision model(s) based?	Civilian agents are all assumed to be equally capable of committing crimes at any given moment, ignoring such factors like socioeconomic status. Civilian agents are also assumed to only call the police when they are the victim of a crime. Additionally, when not involved in a crime, civilian agents only wander aimlessly. Police agents are assumed to be white, and spend all of their time either responding to calls or wandering aimlessly in the police department. In determining whether excessive force will be applied in a given situation, the only factors considered are the race of the perpetrator, the crime rate of the neighborhood, the police agent's racial biases, and the police agent's tendency for violence.
II.i.c Why is/are certain decision model(s) chosen?	Civilian activities, beyond the scope of law enforcement, are irrelevant to the model, at least directly. While such situations as false reports or the reason why people commit crimes — or even how we define a crime — are certainly relevant to conversations surrounding racial inequality in law enforcement, they are omitted from the "bad apples" model for simplicity.

		In real life, police officers spend the majority of their time responding to calls for service, but they spend very little time handling violent crime, and a vast portion of controversy lies in drug law enforcement, for which there is no clear victim or perpetrator. In addition, the race of police officers is relevant not only in individual determinations of whether to apply excessive force, but also in the broader process of establishing community trust in the police. These factors are, again, omitted from the "bad apples" model for simplicity.
	II.i.d If the model/submodel (e.g. the decision model) is based on empirical data, where do the data come from?	Policing data are taken from centralized datasets compiled through such organizations as the U.S. Bureau of Justice Statistics, Campaign Zero, and the Police Data Initative, as well as from city government websites and separate studies conducted by various news organizations. Demographic data come from the U.S. Census Bureau.
	II.i.e At which level of aggregation were the data available?	Data were gathered ranging from the precinct level, to the neighborhood level, to the city level, to the country level.
II.ii Individual Decision-Making	II.ii.a What are the subjects and objects of the decision-making? On which level of aggregation is decision-making modelled? Are multiple levels of decision making included?	Civilian agents primarily decide whether to commit crime, against other civilians. These decisions are based on neighborhood-level data from the U.S. Census Bureau. Police agents primarily decide whether to apply excessive force against civilians in any given situation, which indirectly affects the crime rate of the entire neighborhood. These decisions are based on precinct-level data gathered by city governments and country-level data gathered by the U.S. Bureau of Justice Statistics.

II.ii.b What is the basic rationality behind agent decision-making in the model? Do agents pursue an explicit objective or have other success criteria?	Civilian agents do not have an explicit objective. Police agents aim to respond to the calls to which they are assigned.
II.ii.c How do agents make their decisions?	Agents calculate the chances of a particular decision — for examples, whether to apply excessive force — based on existing data and the circumstances of their situation, and then use random chance.
II.ii.d Do the agents adapt their behaviour to changing endogenous and exogenous state variables? And if yes, how?	Yes — the chance of civilian agents committing crimes is based on the crime rate of the neighborhood and their personal history of interactions with police agents. Police agents' chance of applying excessive force is also based partially on the crime rate of a given neighborhood.
II.ii.e Do social norms or cultural values play a role in the decision-making process?	No.
II.ii.f Do spatial aspects play a role in the decision process?	No.
II.ii.g Do temporal aspects play a role in the decision process?	No.
II.ii.h To which extent and how is uncertainty included in the agents' decision rules?	Agents make all decisions, in part, by random chance.

II.iii Learning	II.iii.a Is individual learning included in the decision process? How do individuals change their decision rules over time as consequence of their experience?	No.
	II.iii.b Is collective learning implemented in the model?	The chances of any civilian agent deciding to commit a violent or property crime, as well as the chances of any police agent deciding to apply excessive force, are partially based on the crime rate of the neighborhood, which updates every timestep based on the crimes that occur and are resolved within it.
II.iv Individual Sensing	II.iv.a What endogenous and exogenous state variables are individuals assumed to sense and consider in their decisions? Is the sensing process erroneous?	Civilian agents can sense the nearest other civilian agents when determining an agent against which to commit a crime. Victims of crimes can sense the identity and race of the perpetrator and transmit this information to police agents. It is not erroneous.
	II.iv.b What state variables of which other individuals can an individual perceive? Is the sensing process erroneous?	All agents can sense race. It is not erroneous.
	II.iv.c What is the spatial scale of sensing?	Civilian agents can mostly sense only the agents in their neighborhood, but when they contact the police operator, the police operator then routes the call to a random available police agent.
	II.iv.d Are the mechanisms by which agents obtain information modelled explicitly, or are individuals simply assumed to know these variables?	The mechanisms by which agents obtain information are modelled explicitly based on their history and their neighbors.

	II.iv.e Are the costs for cognition and the costs for gathering information explicitly included in the model?	No.
II.v Individual Prediction	II.v.a Which data do the agents use to predict future conditions?	None.
	II.v.b What internal models are agents assumed to use to estimate future conditions or consequences of their decisions?	None.
	II.v.c Might agents be erroneous in the prediction process, and how is it implemented?	Not applicable.
II.vi Interaction	II.vi.a Are interactions among agents and entities assumed as direct or indirect?	All interactions between agents are direct.
	II.vi.b On what do the interactions depend?	Interactions depend on random chance initialized by seed data from precincts and cities, except calls for service, to which a random police agent is guaranteed to respond.
	II.vi.c If the interactions involve communication, how are such communications represented?	Calls for service are represented as a message sent by the victim of a crime to a police operator helper agent, which randomly routes the message to a random police agent, which travels to the location of the crime and resolves the situation.
	II.vi.d If a coordination network exists, how does it affect the agent behaviour? Is the structure of the network imposed or emergent?	Not applicable.

II.vii Collectives	II.vii.a Do the individuals form or belong to aggregations that affect and are affected by the individuals? Are these aggregations imposed by the modeller or do they emerge during the simulation?	All police agents belong to a precinct. All civilian agents belong to a neighborhood serviced by the precinct. These aggregations are immutable.
	II.vii.b How are collectives represented?	Precincts are represented as blue squares in the middle of the model, the sizes of which depend on the number of personnel. Neighborhoods are represented as squares scattered throughout the model, the sizes of which depend on the geographic area of the neighborhood. Neighborhoods range in color from red to green based on their crime rates.
II.viii Heterogeneity	II.viii.a Are the agents heterogeneous? If yes, which state variables and/or processes differ between the agents?	Agents are initialized with different races, which are only relevant when police officers decide whether to apply excessive force. They also eventually develop different histories of interactions with police, which alter the crime rate.
	II.viii.b Are the agents heterogeneous in their decision-making? If yes, which decision models or decision objects differ between the agents?	No.
II.ix Stochasticity	II.ix.a What processes (including initialisation) are modelled by assuming they are random or partly random?	Almost all processes are partly random.
II.x Observation	II.x.a What data are collected from the ABM for testing, understanding and analysing it, and how and when are they collected?	Agents' impressions of the police, based on their histories of interactions with the police, and the crime rates of neighborhoods are collected continually throughout the simulation.

		II.x.b What key results, outputs or characteristics of the model are emerging from the individuals? (Emergence)	Generally, neighborhoods that start off with higher crime rates develop even higher crime rates, especially neighborhoods with more people of color, while neighborhoods with lower crimes develop even lower crime rates.
III) Details	III.i Implementat-ion Details	III.i.a How has the model been implemented?	The model was implemented using HASH Core, an ABM development engine using JavaScript.
		III.i.b Is the model accessible, and if so where?	A link to the interactive HASH simulation is available at https://core.hash.ai/simulation/5ef7b2a7478e6ec44c6a600b/police-brutality-and-inequality. The code for the model is available at https://github.com/chena11356/systemic-inequality-policing. For other relevant documents, please visit https://alex-chen.me/#police.
	III.ii Initialisation	III.ii.a What is the initial state of the model world, i.e. at time $t = 0$ of a simulation run?	All police agents are idle, and civilian agents are not involved in any crime. The police department is placed at the center of the model, and neighborhoods are randomly placed around the model.
		III.ii.b Is the initialisation always the same, or is it allowed to vary among simulations?	The exact number of agents, along with agent characteristics like race or racial bias, varies. Additionally, the placement of neighborhoods is entirely random.
		III.ii.c Are the initial values chosen arbitrarily or based on data?	Initial values are chosen based on data. Some values, such as racial bias or tendency for violence, are indirectly extrapolated from data, while other values, such as the crime rate, are directly taken from data.
	III.iii Input Data	III.iii.a Does the model use input from external sources such as data files or other models to represent processes that change over time?	The model can accept seed data from various precincts and cities, or even test data for hypothetical precincts.

III.iv Submodels	III.iv.a What, in detail, are the submodels that represent the processes listed in ‘Process overview and scheduling’?	None.
	III.iv.b What are the model parameters, their dimensions and reference values?	None.
	III.iv.c How were the submodels designed or chosen, and how were they parameterised and then tested?	None.