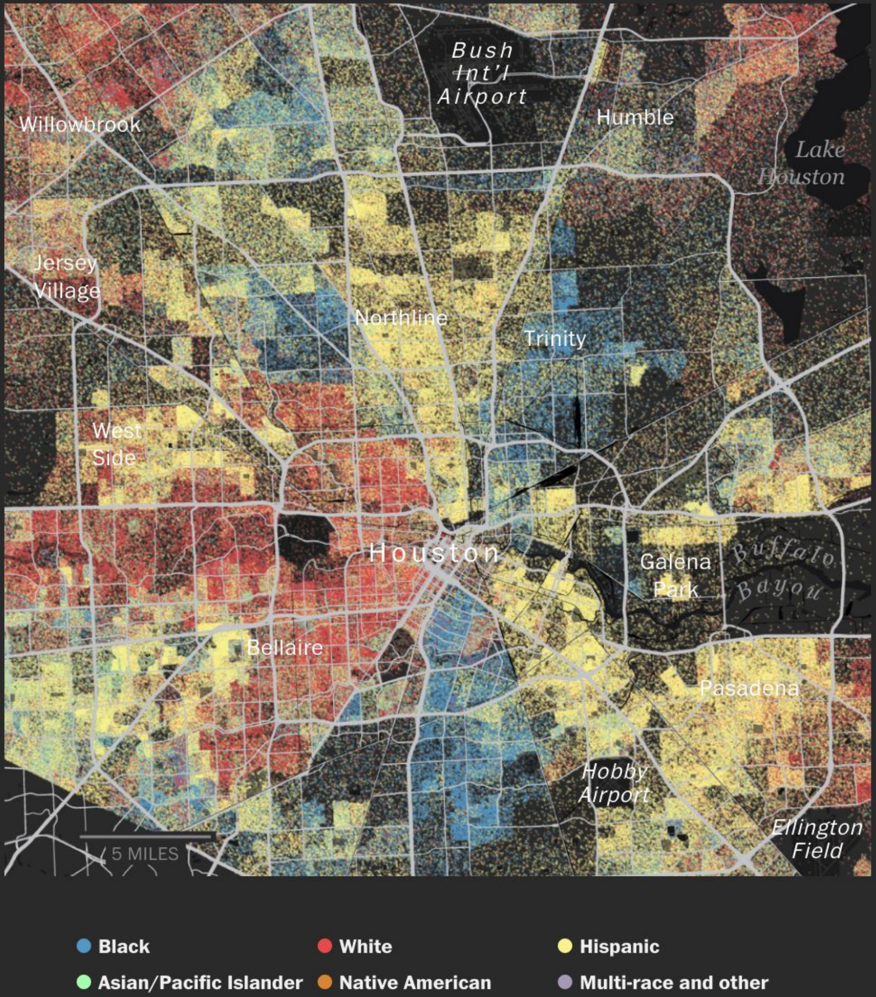

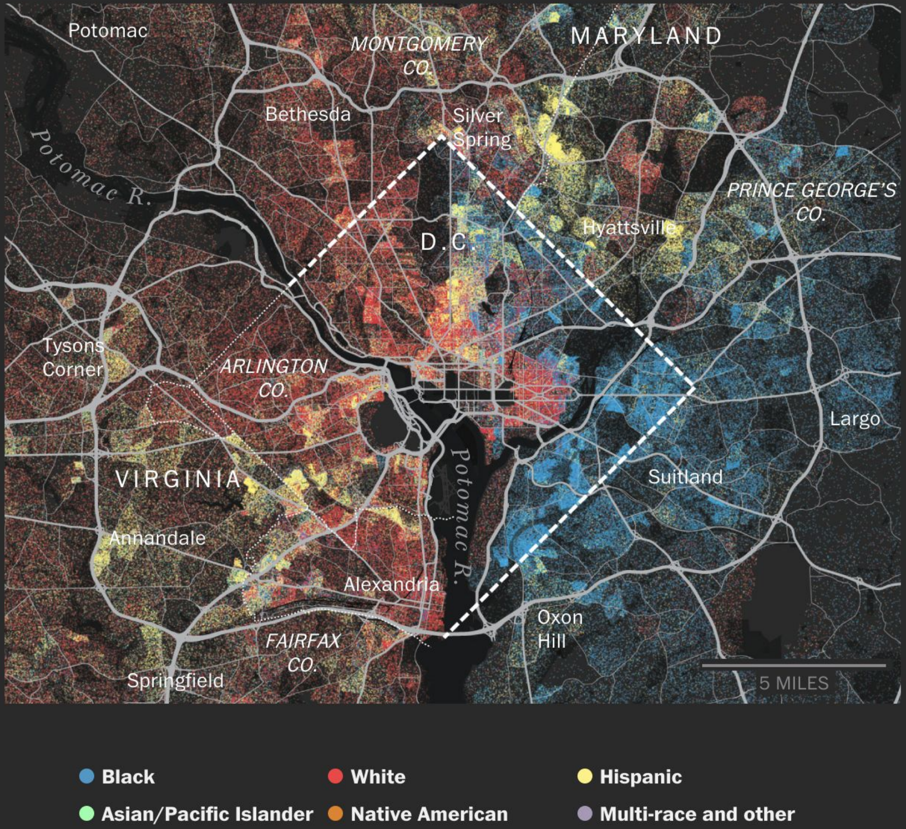

https://www.washingtonpost.com/graphics/2018/national/segregation-us-cities/

Effects of Altruistic Behavior on Schelling's Segregation Model

Jonathan Krahl, Nicola Lo Russo, Richard Schulz

Motivation

- Schelling's model highlights how individual preferences lead to **unintended segregation**.
- Traditional models assume **agents act solely out of self-interest** (egoism).
- Jensen et al. (2018) demonstrated that even a **small fraction of altruistic agents** can significantly improve overall system outcomes.
- Relocation Policies can shape segregation dynamics, but their interplay with altruism is **underexplored**.

State of the Art

1971: Original Schelling model (Thomas C. Schelling)

→ Even mild preferences for similar neighbors lead to **significant segregation**.

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2024: Role of relocation policies in segregation models (Mauro et al.)

→ Different tailored policies can **affect convergence time**.

Our Approach

Combine Jensen et al. (2018) and Mauro et al. (2024) to understand how altruistic behavior can influence segregation under different policies.

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Research question

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Research question
What are the effects of altruism on relocation policies in segregation models?

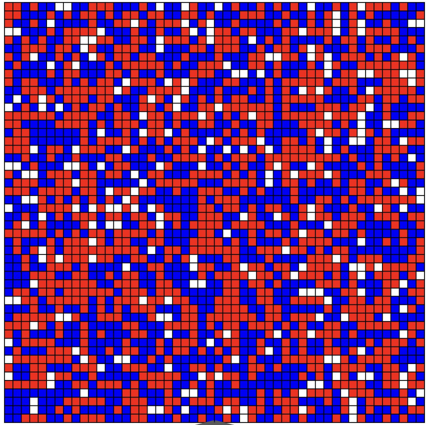
Hypothesis
Altruistic behavior will increase convergence time at a policy-dependant rate.

Schelling Model Recap

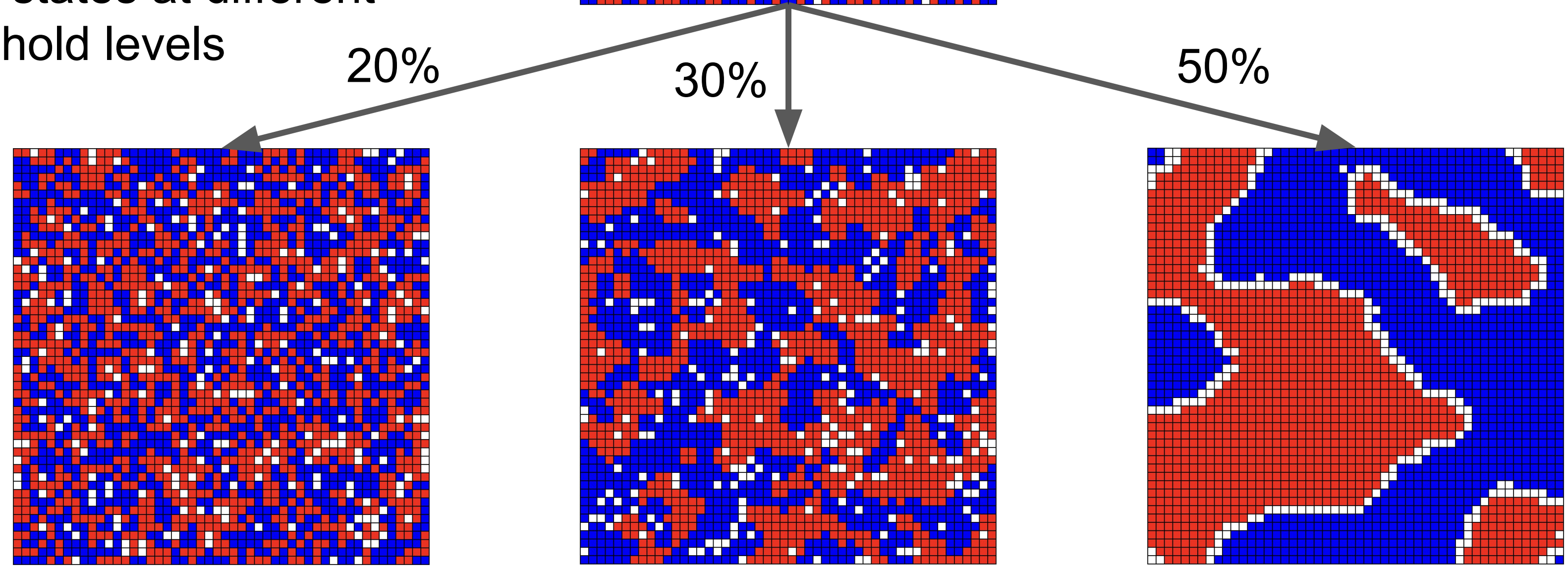
- Explores how individual preferences can lead to large-scale social patterns, especially segregation.
- Premise: Individuals have slight **preferences for neighbors of similar backgrounds.**
- Even mild preferences can result in **significant group segregation.**

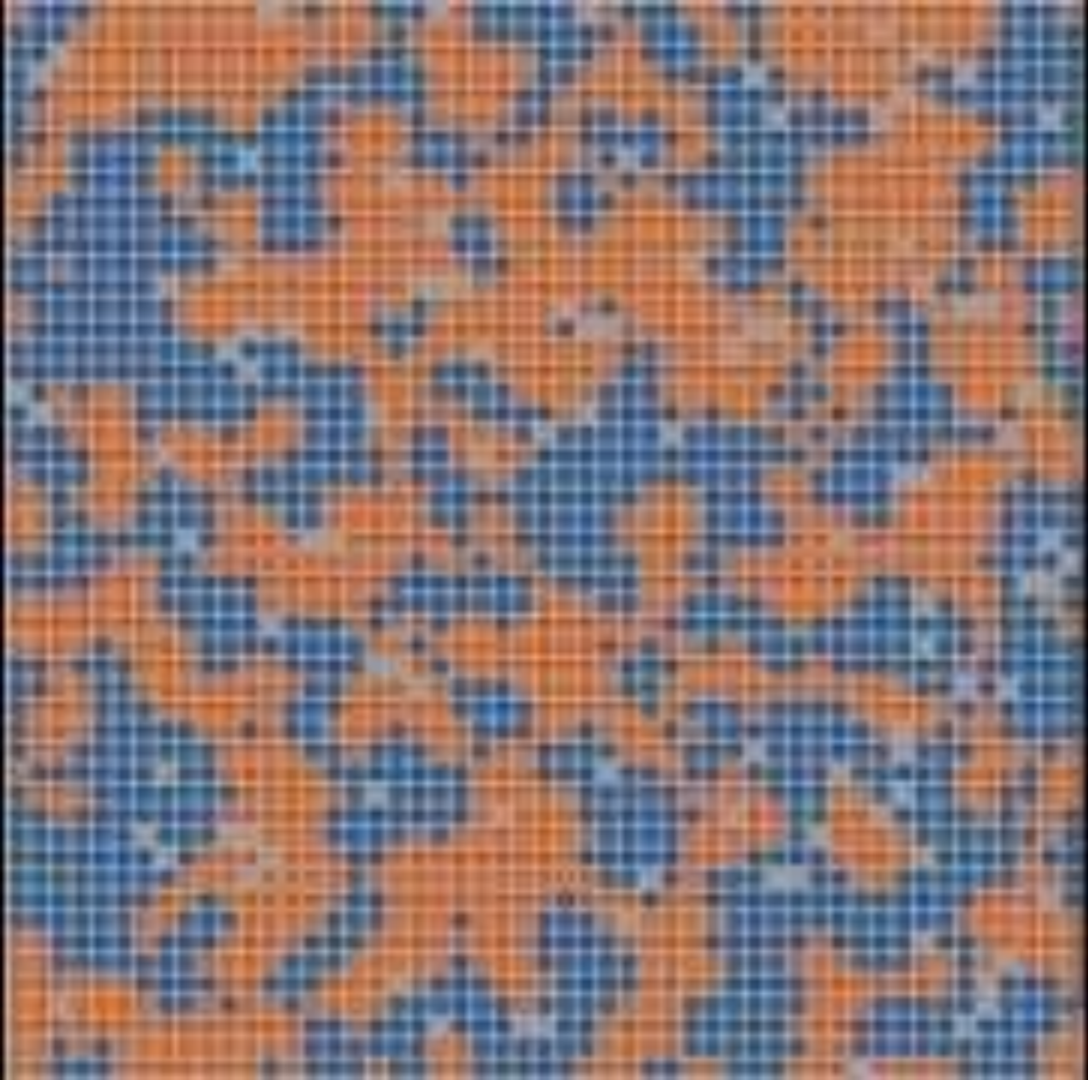
Visualizations source:
http://nifty.stanford.edu/2014/mccown-schelling-model-segregation/

Initial state



Final states at different threshold levels





Relocation Policies Overview

How an agent decides to move.

- **Random**: Agents move to a randomly selected empty cell.
- **Distance-Relevance**: Closer locations are preferred.
- **Minimum Improvement**: Agents move to the first cell that offers any improvement, even if minimal.
- **Similar Neighbourhood**: Prioritizes cells with a neighbourhood similar to the original.
- **Different Neighbourhood**: Prefers cells with economically dissimilar neighbourhoods compared to the original.
- **Maximum Improvement:** Agents move to cells where they would be happy; cells are scored directly proportional to the number of same-class agents.

All relocation policies are present in previous literature.

Similar History Relocation Policies

- Idea: Policies that take the historic occupancies of cells into consideration
- Real world analogy: Tenants preferences shape infrastructure development in their neighborhood
- Two new policies: **Similar history neighborhood** and **similar history cell**

How it works

- Rate empty cells by looking at their past occupancy
- Randomly choose cell among cells with k-highest scores

Let:

- $H_c = \{h_1, h_2, \ldots, h_n\}$: The history of occupancies for the cell c.
- a: The type of the current agent considering relocation.

The score is:

$$\text{Score}_{\text{cell}}(c, a) = \sum_{i=1}^{n} \delta(a, h_i)$$

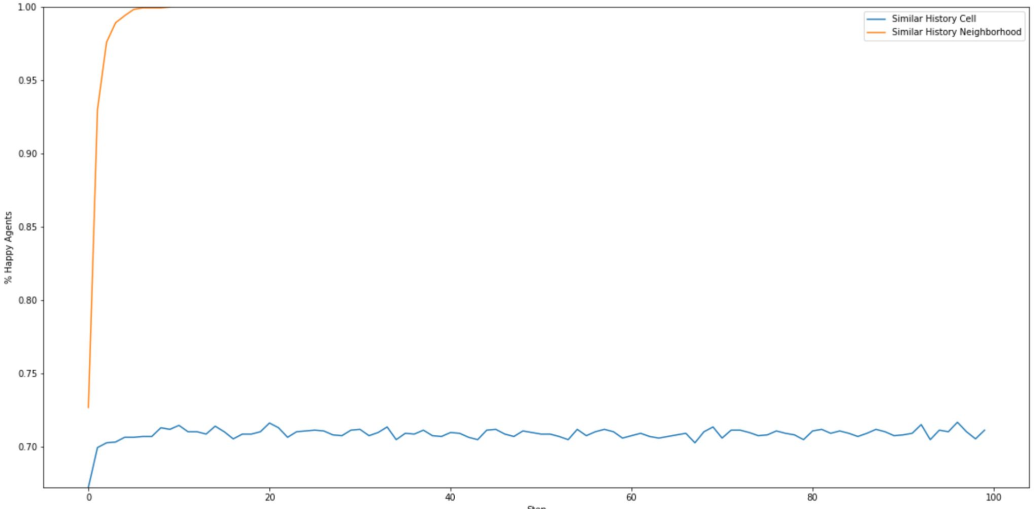
where $\delta(a, h_i)$ is defined as:

$$\delta(a, h_i) = \begin{cases} 1 & \text{if } a = h_i, \\ 0 & \text{otherwise.} \end{cases}$$

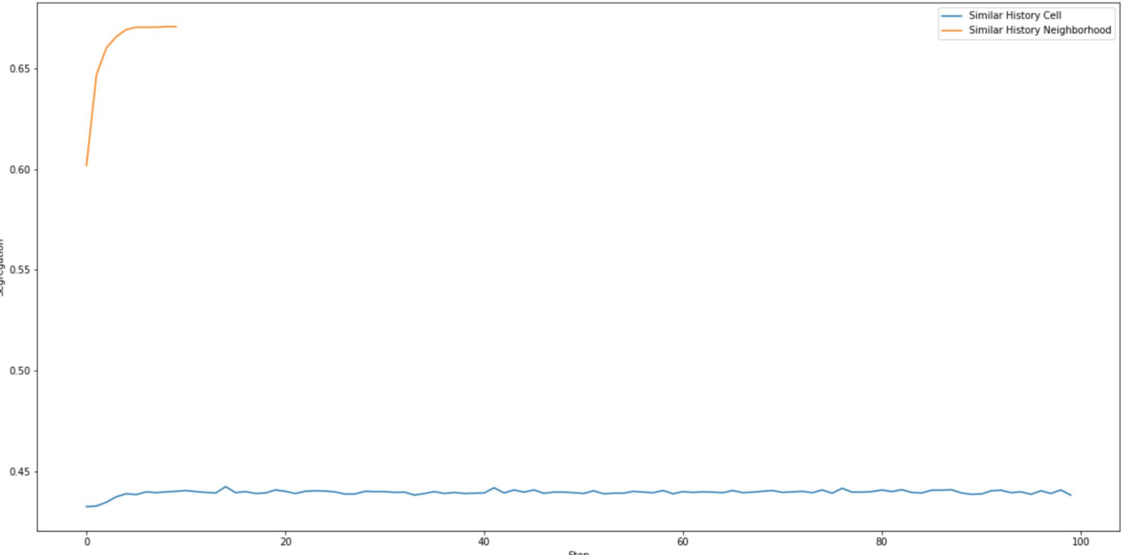
Results - Comparing convergence time and segregation

	policy	Step		segregation		perc_happy	
		std	mean	std	mean	std	mean
0	maximum_improvement	0.836660	4.2	0.005616	0.745754	0.00000	1.000000
1	minimum_improvement	4.037326	7.6	0.002298	0.547729	0.00000	1.000000
2	similar_history_cell	0.000000	100.0	0.005675	0.397338	0.00908	0.661172
3	similar_history_neighborhood	1.643168	9.2	0.007637	0.693167	0.00000	1.000000

Results #2



Similar History Cell
Similar History Neighborhood
% Happy Agents
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0
20
40
60
80
100



Similar History Cell
Similar History Neighborhood
0.65
0.60
0.55
0.50
0.45
0
20
40
60
80
100

Altruism

How to define altruism? Collective happiness is more important than personal happiness.

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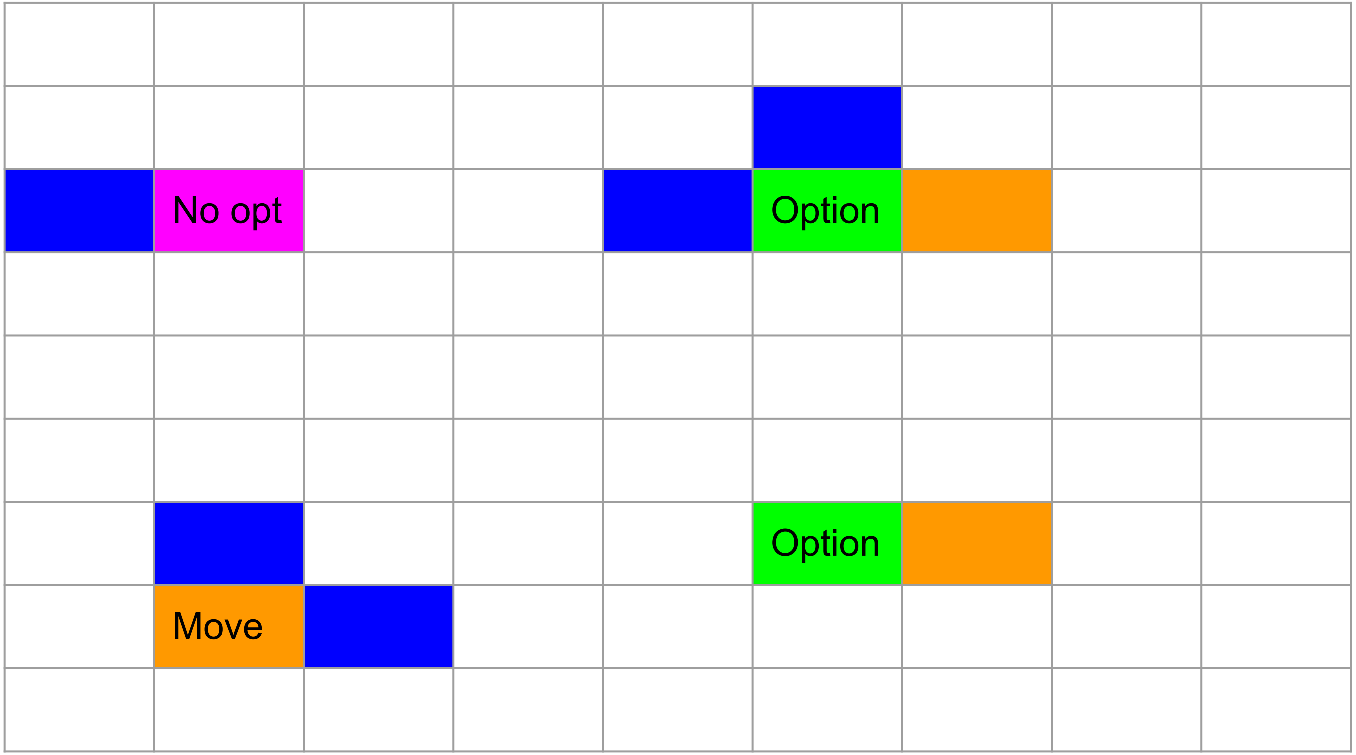
How to define altruism? Collective happiness is more important than personal happiness.

We take the definition from [Jensen, 2018]: “[An agent] who act[s] to improve the collective utility [...] **[A]s objective function [...] altruists consider the variation of the overall utility ΔU**.”

$$U = \sum_{i=1}^{n} u_i$$

happiness of agent i

Happiness Delta Calculation



Simulation Setup

Grid setup:

- 50 x 50 grid
- Minority Agents Proportion: 40 %
- Density: 75 %

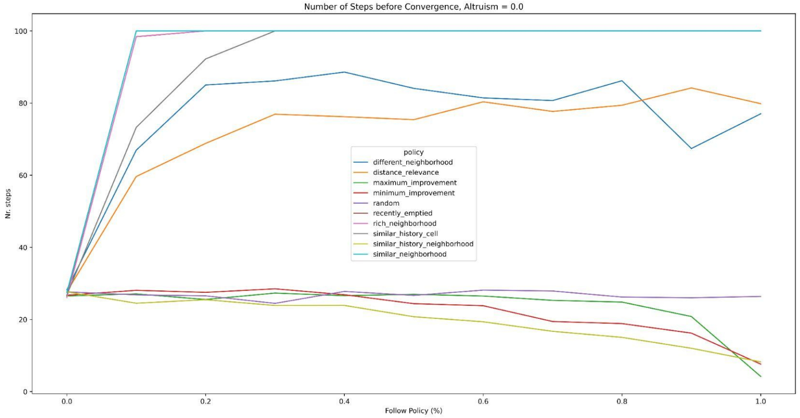
Agents' Properties:

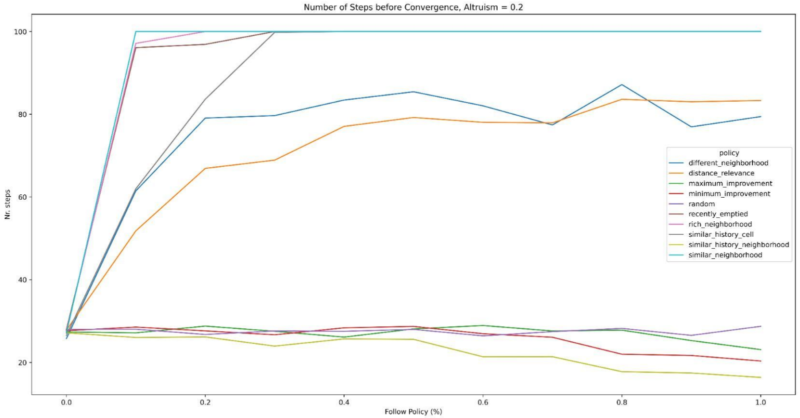
- Homophily Parameter: 3
- Follow Policy Parameter: range(0,110,10)

Result Evaluation:

- Take the average value of 50 simulations.

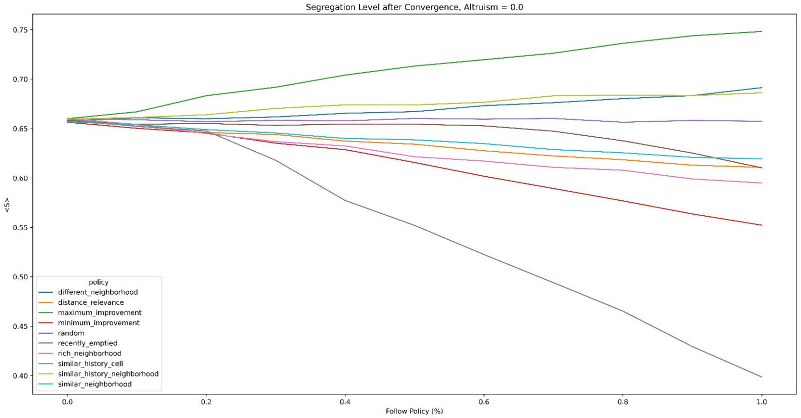
Results - Altruism 20% - Convergence Rate

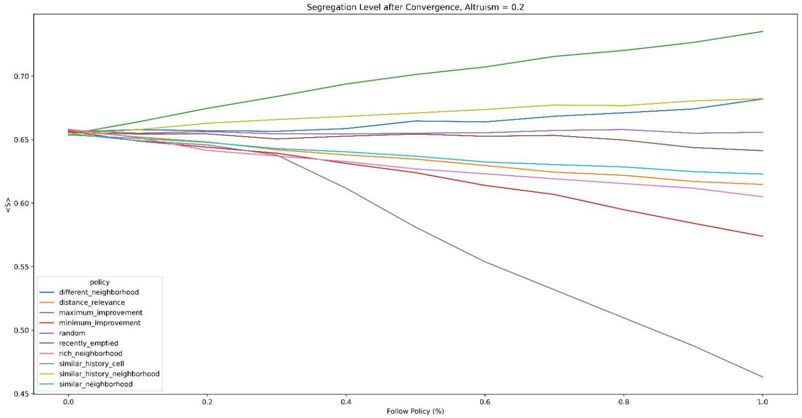




Different policies are differently sensitive to altruism. Altruism significantly affects recently_emptied, similar_history_cell. Some policies also show step size reduction.

Results Altruism 20% - Segregation Rate





Altruism smoothes the segregation behavior and level. It delays the kink of similar history cell.

Takeaways and limitations

- Policy effects may be influenced by whether agents behave altruistically or egotistically.
- Altruism smoothes the segregation rate. It can reduce the steps of convergence rate for some policies (proof of concept).

But:

- Policies often address local happiness but fail to capture broader dynamics.
- Real-world altruism is more nuanced and context-dependent.
- People do not often agree on an “optimum”.
- Policies are difficult to apply and analyze in real-world.
- We could try an approach that mixes policies.
- Increased computational power could show better convergence results.

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[1] Schelling, T. C. (1971). Dynamic models of segregation. Journal of Mathematical Sociology, 1(2), 143-186.

[2] Mauro, G., & Pappalardo, L. (2024). Dynamics of Policy-Driven Segregation in Schelling Models. In Proceedings of the Workshops of the EDBT/ICDT 2024 Joint Conference (March 25-28, 2024), Paestum, Italy. CEUR Workshop Proceedings.

[3] Jensen, P., Matreux, T., Cambe, J., Larralde, H., & Bertin, E. (2018). Giant Catalytic Effect of Altruists in Schelling's Segregation Model. Physical Review Letters, 120(20), 208301.