9^{th} International Conference on Computational Social Science IC^2S^2
July 17-20, 2023, Copenhagen, Denmark

A Mobility-constrained Segregation Model

Keywords: Agent Based Models, Segregation, Schelling Model, Human Mobility, Urban Dynamics

Extended Abstract

The famous Schelling's model [3] suggests that even when individuals are open to living in neighborhoods with different ethnicities and would move only when their ethnicity is a small minority, a city may still end up sharply segregated. Although disarmingly simple, Schelling's model provides a fascinating look at how individuals might produce a non-desirable collective outcome even without intending to. Many variants of the model have been proposed so far [2], in all of which unhappy agents choose the next location *randomly* on the grid, pursuing individual happiness without any constraints related to mobility in the choice of the destination. However, extensive research on human mobility and migration suggests that distance and location popularity do play a crucial role in location choices [1].

In this work, we implement a *mobility-constrained* segregation model, where agents move accordingly to dynamics inspired by the gravity law of human mobility [1], i.e., agents prefer nearby locations to distant ones and more relevant locations to less relevant ones. In detail, an agent in location A selects the next destination, B, based on a probability $P(B)$ that depends on the distance $d(A,B)$ and the relevance $val(B)$: $P(B) \propto val(B)^{\alpha} d(A,B)^{\beta}$, where α and β are exponents (parameters of the model) and $val(b)^{\alpha}$ and $d(a,b)^{\beta}$ are two power-law functions.

We assume two agent types and conduct several simulations on grids of different sizes and proportions of agent types, cell occupancy rates, and homophily thresholds. A simulation ends when all agents are happy or after a maximum of 500 steps. We quantify the final level of segregation as the average segregation of each agent, calculated as the ratio of neighbors belonging to the same group to the total number of neighbors.

We find that, for $\beta < 0$ (i.e., the agent prefers nearby locations over far ones), converges to a final level of segregation lower than the classic Schelling model and in a higher number of steps. Moreover, the lower β, the lower the final level of segregation and the longer the model's convergence time. In other words, adding mobility constraints leads to a segregated city, but slowly and with low segregation levels than a city with random movements. We also investigate the role of $val(b)^{\alpha}$, varying α while $\beta = 0$. We find that increasing the importance of cell relevance brings an elongation of convergence time, suggesting that agents compete for the same relevant cells thus being frequently close to the opposite group, thus increasing the time needed to find an equilibrium.

Our study provides interesting insights into the relationship between segregation dynamics and human mobility laws, open the question on how to measure this relationship in real data about real urban dynamics.

References

[1] Hugo Barbosa-Filho et al. Human mobility: Models and applications. *Physics Reports*, 734:1–74, 2018.

[2] Tim Rogers and Alan J McKane. A unified framework for schelling's model of segregation. *J Stat Mech*, 2011(07):P07006, 2011.

[3] Thomas C. Schelling. Dynamic models of segregation. *Journal of Mathematical Sociology*, pages 143–186, 1971.

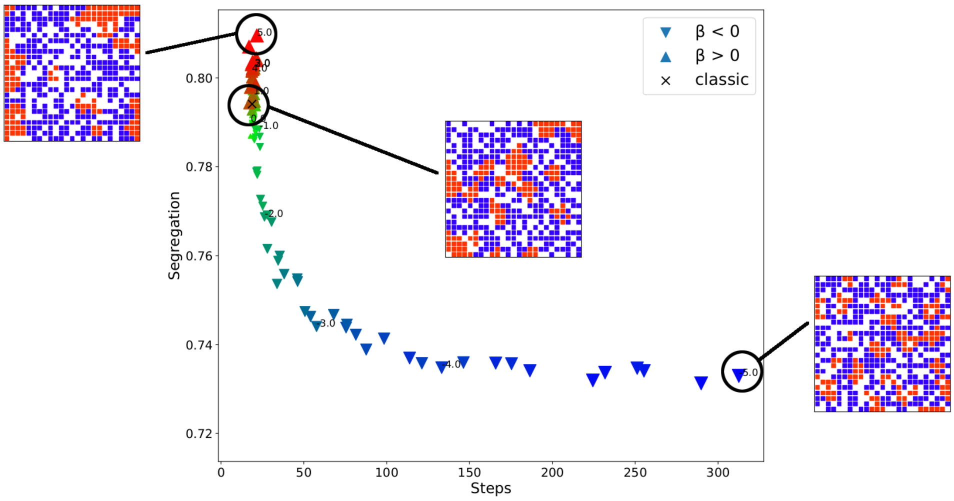

Figure 1: Each triangle corresponds to a value of β and is the average of segregation index and number of convergence steps over 100 simulations. The lower β the higher the number of the steps and the lower the final segregation level. We also show final grid configuration taken from three simulations: note how the rightmost, corresponding to a high value of β, has the lowest segregation overall.