

The Impact Of Initial Value Distributions On Ethnic And Value Segregation

Schelling's Model Extended

1. Introduction

Segregation remains a pressing social issue, and one of the most well-known models for understanding its dynamics is Thomas Schelling's Agent-Based Model of Segregation. Schelling's model, which was developed in the 1970s, explores how individual preferences, even when the majority of people do not hold high preferences for homogeneity can contribute to wider patterns of racial or ethnic segregation. It does this by using a straightforward but effective simulation approach. Agents in the original model stand in for people who would like to live close to others who have similar characteristics, like ethnicity. Schelling showed how micro-level decisions eventually compound into macro-level consequences by demonstrating that even little preferences for coexisting with like-minded people can eventually result in extremely segregated groups. This agent-based model, which provides insights into how individual behaviours might result in unintentional societal patterns like segregation, has become a fundamental instrument in the study of social dynamics (Rocco & Jan, 2018).

Paolillo and Lorenz (2018) added a significant expansion to Schelling's model by including agents who are value- and ethnically-oriented. They added value homophily to the model, which allowed agents to be motivated by cultural preferences or shared values rather than just ethnic homophily, which is the preference for neighbours of the same race. This expansion enables a deeper investigation of segregation, in which people's social identities are shaped by their values as well as their ethnicity. Paolillo and Lorenz's addition brings the model closer to the intricacies of contemporary cultures by adding value-oriented agents. In these societies, people choose where to reside based on the intersection of many dimensions of identity, such as ethnicity and values (Rocco & Jan, 2018).

By using a continuous value variable instead of a binary one, this paper expands on previous research by looking into the effects of initial value distributions on segregation dynamics. This research specifically attempts to explore the effects of the heterogeneity of value-oriented agents at the start of the simulation on the final segregation patterns in a mixed population of ethnic and value-oriented agents. We can investigate whether a more varied or homogenous starting distribution of values results in higher or lower levels of segregation over time by expanding the model with a continuous value scale.

Research Questions

1. What is the impact of Initial Value Distributions on ethnic and value segregation?
2. How do value and ethnic homophily interact in shaping segregation when value orientations are continuously distributed?

2. Modeling Approach

Our model incorporates a Fraction of value orientation to further examine the dynamics of segregation in a multi-dimensional framework, building on the extended Schelling model of Paolillo and Lorenz (2018). Two categories of agents—ethnic-oriented agents and value-oriented agents—center the central idea. The ethnicity of their neighbours is the main concern of ethnic-oriented agents, while value-oriented agents are impacted by how similar their neighbours' continuous value variable is, which has a range of 0 to 1 (Rocco & Jan, 2018).

Each agent in this model is motivated by a homophily preference; value-oriented agents choose neighbours who share their values, while ethnic-oriented agents like neighbours who share their ethnicity. Crucially, we present the idea of a preference weight that determines how important ethnic homophily is in comparison to value homophily. This gives us the opportunity to study the ways in which these two types of preference interact and affect the dynamics of segregation as a whole.

Values of agents evolve through time in accordance with an adaptive, dynamic process. Value-oriented agents modify their orientation in accordance with their neighbours' average values. This is similar to the social influence processes that occur in real life, when people change their values according to the environment in which they live. The social environment is continuously changed by this process, which creates a feedback loop that may result in dynamic equilibria. Additionally, we quantify static equilibrium, which occurs when agents stop moving and have identified a neighbourhood that meets their preferences (Rocco & Jan, 2018).

NetLogo Implementation

An agent-based modelling environment; NetLogo was used to implement the model. A grid with patches occupied by agents, each of whom has a preference based on their ethnicity or values was made. The agents' happiness, which is based on their homophily thresholds (ethnic or value), determines the relocation criteria. If an agent is dissatisfied, it means that their neighbours don't match the necessary level of similarity (either in terms of values or ethnicity).

The value-oriented agents have a continuous variable (between 0 and 1) that represents their value orientation. A binary classification based on an agent's ethnicity (e.g., majority or minority groups) is used to represent ethnic-oriented agents. An agent will randomly move to a fresh, empty patch if it is unhappy with its current location. Value-oriented agents adjust their orientations based on the average value orientation of their neighbours in each iteration. This adaptive process highlights the dynamic character of value change in response to social influence.

Value segregation and ethnic segregation were the two variables we used to quantify segregation. Value segregation measures how close an agent's value orientation is to the average values of its neighbours, whereas ethnic segregation is determined by the percentage of an agent's neighbours that are of the same ethnicity. We also measure agent happiness, which is the proportion of

agents who are content with their neighbourhood, and neighbourhood density, which is the average number of neighbours each agent has.

Key Equations

Building on Paolillo and Lorenz's (2018) adaptation, we used the following key equations to measure segregation and happiness:

1. Ethnic Segregation:

Ethnic Segregation = $\text{Count of Same-Ethnicity Neighbors} \setminus \text{Total Neighbors}$

This measures how many of an agent's neighbors share the same ethnicity. High values indicate a segregated environment.

2. Value Segregation:

Value Segregation = $\text{Count of Similar Value Neighbors} \setminus \text{Total Neighbors}$

This measures how close an agent's neighbors' values are to its own.

3. Agent Happiness:

Happiness = True if $(\text{Similar Neighbors} \setminus \text{Total Neighbors}) \geq \text{Homophily Threshold}$

Agents move to a new location if they are not happy.

Initial Setup

The agents in the model are first spread randomly around the grid. The Fraction Value-Oriented parameter determines the starting preferences of the agents. The number of value-oriented (circles) vs ethnically-oriented (squares) agents is determined by the fraction value-oriented parameter. Sliders regulate the homophily thresholds for both ethnicity and value, allowing the experiment to change these parameters. Value-oriented agents are given a continuous value, ranging from 0 to 1, at random to indicate their ideological or social preferences.

Research Methodology

To see the role of the Fraction Value-Oriented on segregation patterns, we perform a series of experiments using NetLogo's BehaviorSpace to vary the fraction of value-oriented agents (e.g., 20%, 80%) and ethnic and value homophily thresholds. Measuring the results in neighbourhood density, agent contentment, and ethnic and value segregation under these various settings is the key objective.

Parameter involve:

- Varying the Fraction Value-Oriented to test the impact on segregation.
- Exploring the interaction between ethnic and value homophily to assess how each preference influences relocation patterns.
- Tracking key metrics such as ethnic segregation, value segregation, neighborhood density, and overall agent happiness.

By conducting these experiments, we hope to shed light on the complexities of segregation phenomena that arise in real life by examining how the Fraction of value-oriented agents changes and affects the balance between ethnic and value segregation.

3. Simulation Results and Discussion

Impact of Initial Value Distribution

We note how segregation emerges depending on how the initial distribution of "values" (continuous variables that indicate preferences) is distributed. Value orientation in our paradigm can stand in for individual differences in attitudes, beliefs, or even preferences. The purpose of the experiment was to see how the agents behaved under various conditions of ethnic and moral homophily.

Experiment 1: High Value Orientation (80%).

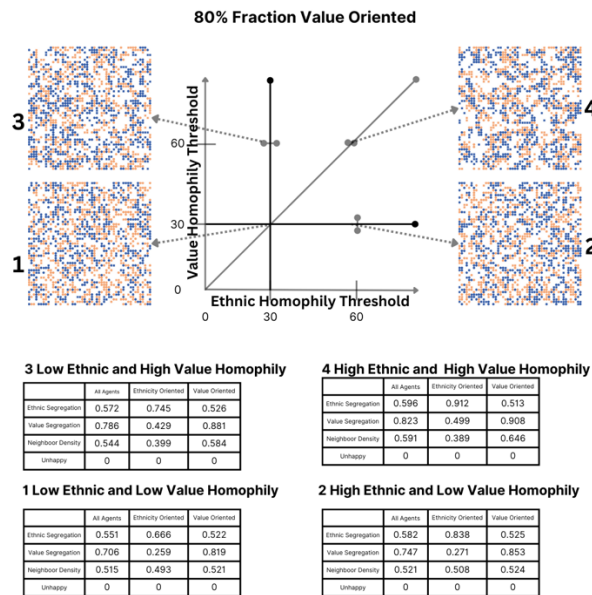


Figure 1 Experiment 1: High Value Orientation (80%)

Observation:

As for the first finding, we observe that the fraction value orientation of 80%, which regulates the percentage of value-oriented turtles in the population relative to ethnic-oriented turtles, is important in defining the general dynamics of segregation. Value-oriented agents make up 80%

of the population in this experiment, which means that when building neighbourhoods, most agents put values above ethnicity. This is how the outcome is affected by this factor:

Impact of Fraction Value-Oriented (80%) on Segregation:

1. Dominance of Value Preferences: Value homophily, as opposed to ethnic homophily, will be the primary factor in neighbourhood construction because 80% of the population is value-oriented. Value segregation is more noticeable throughout the quadrants when value homophily is high, as in Quadrants 3 and 4, because value-oriented turtles would seek out neighbours based on value similarity.

2. Ethnic-oriented Minority: The 20% of the population that is left is ethnically orientated, which means that these turtles cherish their ethnicity more than their morals. Even though it is a smaller minority, this ethnic-oriented group can still significantly affect ethnic segregation, especially in cases when ethnic homophily is prominent. For example, despite being a minority, the ethnic-oriented agents create more identifiable ethnic clusters in Quadrants 2 and 4, where ethnic homophily is emphasised.

3. Interaction with Value and Ethnic Homophily: Most of the population (value-oriented agents) prefers to group together based on shared values in areas with strong value homophily, such as Quadrants 3 and 4. Value-oriented agents have a lower ethnic segregation score than ethnic-oriented agents, which can be explained by the fact that this reduces the influence of ethnic homophily on them. On the other hand, even though they are the minority, the ethnic-oriented agents (20%) create substantial ethnic clusters where ethnic homophily is high, such as in Quadrants 2 and 4. The overall ethnic segregation for all agents is still lower than it would be if the population were more evenly divided between ethnic and value orientations, though, because the majority of the population is value-oriented.

Conclusion:

Segregation patterns are dominated by value preferences, as seen by the 80% of turtles that are value-oriented. Value-oriented agents favour substantial value-based segregation in situations where value homophily is prevalent. As a result, there is less ethnic segregation among value-oriented turtles since ethnicity has less of an impact on neighbourhood development. The 20% ethnically orientated minority can, however, still create unique ethnic clusters, especially in situations where ethnic homophily is prioritised. Thus, the degree to which segregation is motivated by values as opposed to ethnicity is determined by the fraction value orientation parameter.

Experiment 2: Low Value Orientation (20%)

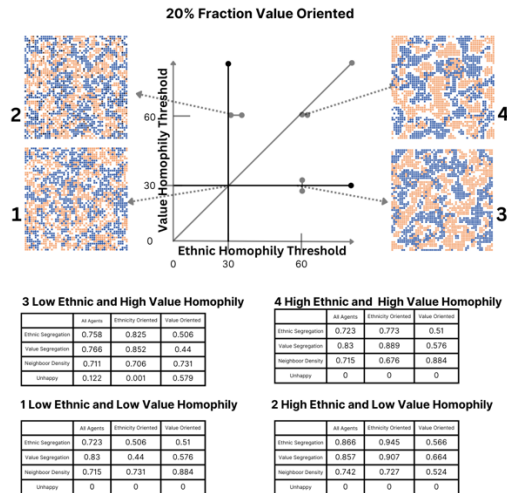


Figure 2 Experiment 2: Low Value Orientation (20%)

For the second observation, 20% of the population is value-oriented, meaning that the majority of the agents (80%) are ethnic-oriented, which shifts the dynamics compared to the 80% value-oriented scenario. Here's how this factor influences the outcomes:

Impact of 20% Fraction Value Oriented on Segregation:

1. Dominance of Ethnic Preferences: Ethnic homophily emerges as the main force behind segregation when a majority of agents have an ethnic orientation. Ethnic-oriented agents create substantial clusters based on shared ethnicity in Quadrants 2 (High Ethnic Homophily, Low Value Homophily) and Quadrant 4 (High Ethnic Homophily, High Value Homophily), where this is very visible. On the other hand, ethnic segregation is more mild in Quadrants 1 and 3 (Low Ethnic Homophily) but still higher than in the 80% value-oriented scenario.

2. Value-Oriented Minority: Value homophily has a major influence on the formation of value segregation, despite the fact that value-oriented agents make up just 20% of the population. This is notably obvious in Quadrants 3 (Low Ethnic Homophily, High Value Homophily) and Quadrant 4 (High Ethnic Homophily, High Value Homophily). Despite being a minority group, value-oriented agents exhibit substantial value-based clustering in quadrant 3, as indicated by their Value segregation of 0.852. Value segregation among value-oriented agents reaches 0.889 in quadrant 4, which is considerably higher. Value-oriented agents are better incorporated into the general population and value segregation is less noticeable in Quadrants 1 and 2, where value homophily is minimal.

3. Interaction with Value and Ethnic Homophily: Depending on the quadrant, the relationship between ethnic homophily and value produces distinct patterns of segregation. Value-oriented agents establish significant clusters based on shared values in Quadrants 3 and 4 (High Value Homophily), even in cases when ethnic homophily is also high (as in Quadrant 4). Because they strongly prefer value similarity, these agents remain recognisable even though they are in the minority. Low Value Homophily's first and second quadrants: Value-oriented agents integrate

more into the overall population when value homophily is low, as demonstrated in Quadrant 1, where value and ethnic segregation are both considerable. Because the bulk of ethnically orientated agents exhibit substantial ethnic homophily, ethnic segregation continues to be prominent in Quadrant 2.

Conclusion:

Value orientation accounts for 20% of the population, and in most quadrants ethnic segregation becomes prominent, particularly when ethnic homophily is significant. Strong ethnic clustering is caused by a majority of ethnically orientated agents. Value-oriented agents do, however, exhibit strong value-based clustering when value homophily is large, despite being a minority. On the other hand, ethnic and value segregation are more modest in scenarios with low homophily in both dimensions, allowing for more diverse neighbourhoods. Since ethnic preferences drive segregation in most circumstances, the 20% of value-oriented people has less influence on the overall dynamics of segregation than when value-oriented agents represent the majority (80%).

Results and Discussion

Value segregation predominates the outcomes in the case where 80% of the agents exhibit value orientation. This indicates that, rather than ethnicity, the value homophily parameter is the main mechanism causing segregation. We saw an impact of value homophily on the agents. As seen in Quadrants 3 and 4, high value homophily causes a considerable degree of segregation among value-oriented agents. Value-oriented agents create cohesive clusters based on common values even in cases where ethnic homophily is high. In this case, we also noticed a Lower Ethnic Segregation. Ethnic segregation is often smaller in all quadrants than in the 20% fraction scenario since the majority of people are value-oriented. From an ethnic standpoint, value-oriented actors are more prone to ignore ethnic differences, which results in more ethnically mixed neighbourhoods. Finally, we noticed that homophily parameters had an influence. Value-oriented agents, independent of the ethnic homophily threshold, dominate the segregation patterns in Quadrants 3 and 4, where value homophily is high.

Since 80% of the population is ethnically orientated, ethnic segregation will predominate in the scenario where only 20% of the agents are value-oriented. The influence of ethnic homophily was one of the key findings. In this case, segregation is shaped by ethnic homophily to a far greater extent. Significantly higher levels of ethnic segregation are found in quadrants with high ethnic homophily (Quadrants 2 and 4), especially among agents who are ethnically orientated. Moderate Value Segregation was another observation. Value-oriented agents are rare in the population, therefore even if they still cluster when value homophily is large (Quadrants 3 and 4), the overall effect on the population is less. Although value segregation still happens, it has less of an effect on the dynamics as a whole. Finally, we noticed Low Homophily Mixed Neighbourhoods. Segregation is more modest in Quadrant 1 (low homophily for both ethnic and value dimensions), where mixed neighbourhoods are beginning to form. However, because they are more in number, ethnically orientated agents continue to maintain some level of segregation.

Comparison of the Two Scenarios

Dominant Segregation Mechanism:

- In the 80% value-oriented scenario, segregation is driven primarily by value homophily. Ethnicity plays a smaller role, as the majority of agents prioritize shared values.
- In the 20% value-oriented scenario, ethnic homophily becomes the dominant driver of segregation, as most agents are ethnic-oriented, resulting in stronger ethnic clustering.

Impact of High Homophily:

- In both scenarios, high homophily in either dimension leads to stronger segregation. However, in the 80% value-oriented scenario, high value homophily has a much larger impact, while in the 20% value-oriented scenario, high ethnic homophily dominates.

Integration and Diversity:

- In the 80% value-oriented scenario, integration occurs more readily from an ethnic standpoint, particularly in Quadrants 1 and 3, where value-oriented agents dominate. Mixed neighborhoods are more common in these cases.
- In contrast, in the 20% value-oriented scenario, integration is less common, and ethnic clustering is much stronger, especially in Quadrants 2 and 4. Even in Quadrant 1, where homophily is low in both dimensions, ethnic segregation persists due to the majority of agents being ethnic-oriented.

The percentage of value-oriented agents modifies the dynamics of social segregation in a major way. Value homophily shapes segregation patterns and promotes greater ethnic integration when value-oriented agents are the majority. Stronger ethnic segregation results from the dominance of ethnic homophily among value-oriented agents in the minority. These results imply that, even in the presence of diverse degrees of homophily, a society's ethnic or value orientation plays a critical role in determining how various forms of segregation develop.

4. Conclusion

In order to better understand how different percentages of value-oriented agents influence patterns of ethnic and value segregation, this paper examined the effects of adding a continuous value variable to Schelling's model of segregation. The findings show that a key factor influencing the dynamics of segregation is the Fraction Value-Oriented parameter. Value segregation tends to increase whereas ethnic segregation tends to decrease as the proportion of value-oriented agents rises. This research indicates that, in some situations, shared values may lessen the visibility of ethnic differences; yet, the degree of value homophily is also a significant factor in establishing the general patterns of segregation.

The incorporation of a continuous value variable contributes to our comprehension of segregation by demonstrating the substantial impact that preferences derived from non-ethnic characteristics can have on social groups. Value preferences capture a range of similarity as opposed to ethnic preferences, which are binary, enabling more complex agent interactions and segregation results. As a result, the model becomes more accurate representation of real-world

social dynamics, where people frequently form groups based on shared ideologies, cultural norms, or other values in addition to their ethnicity.

Our results imply that programs intended to foster social integration and diversity would be better served by emphasising individual common ground and shared values in addition to ethnic diversity. Ethnic segregation may be lessened, for instance, by creating settings where people from different ethnic backgrounds can connect over common interests or ideals. This model could be expanded in the future to investigate the interactions between value and ethnic preferences and other social determinants like education and economic position. This would help to guide methods for promoting more integrated communities.

To sum up, our model adds to the expanding corpus of research examining intricate social dynamics by illuminating the ways in which continuous variables, such as values, influence segregation. These results may have use in public policy as well as scholarly study, especially in initiatives to improve social cohesiveness in varied societies.

Bibliography

Rocco, P., & Jan, L. (2018, August 27). *RoccoPaolillo/EthnicValueSegregation: version 0.1*. From Zenodo: <https://zenodo.org/records/1404223>

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