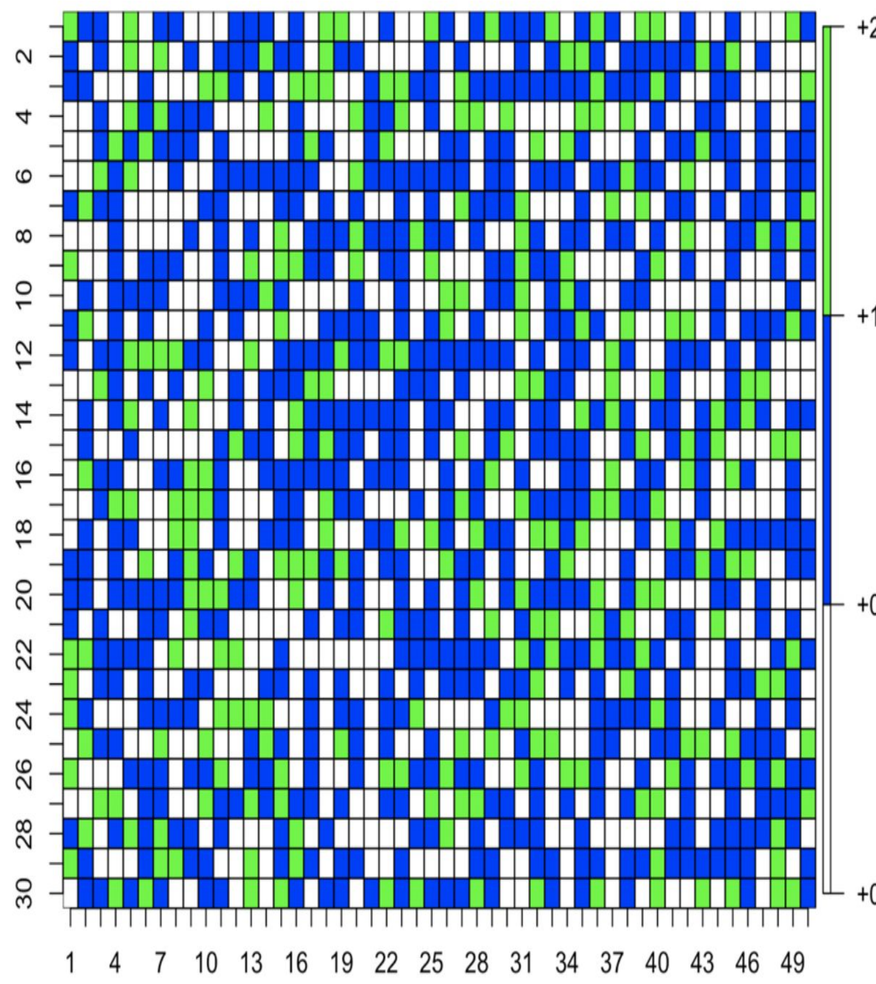
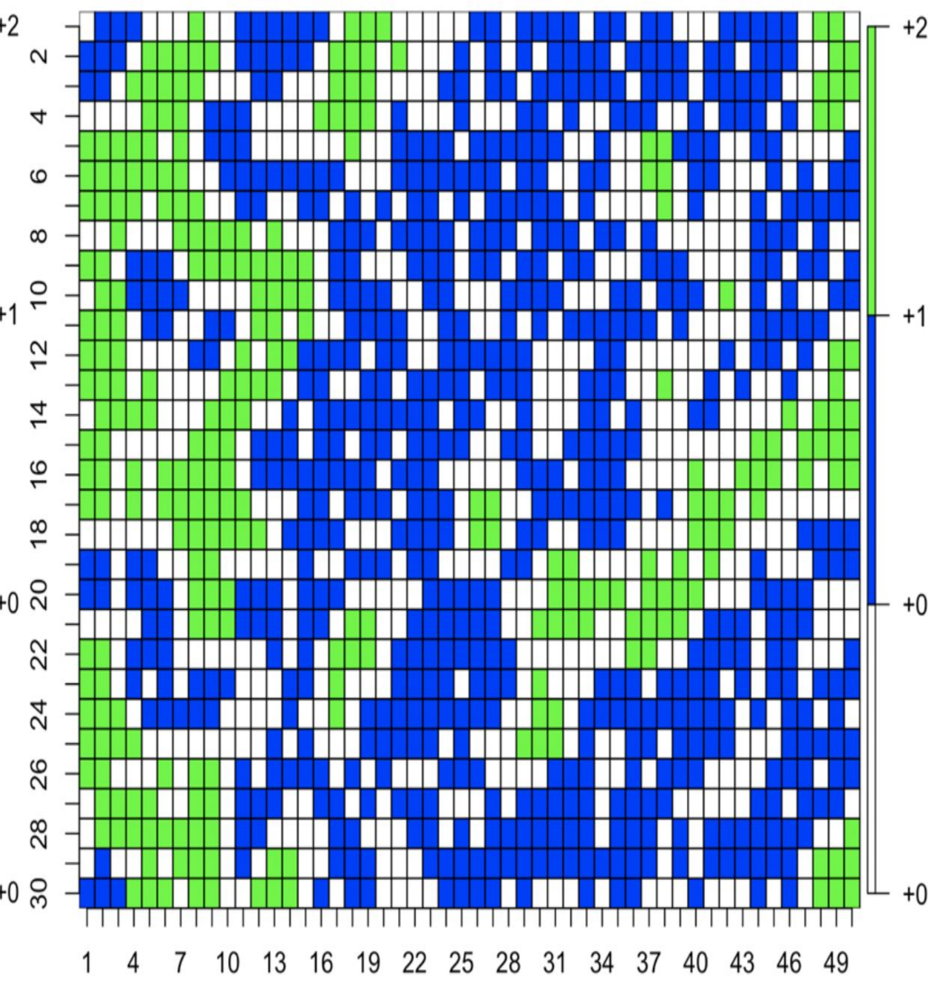
Modeling Segregation using Agent-Based Modeling

Lydia Duan. Lizzie Ferguson. Sophie Moore.



Randomized model before simulation with 0.7 likeness and a segregation metric of approximately .50.



Randomized model after simulation with 0.7 likeness and a segregation metric of approximately .99.

METHODOLOGY

Our model loosely follows Schelling's well known segregation model. We represent a neighborhood of people using an arbitrary matrix, where each cell represents a living space for one household. Each cell is randomly assigned either to be empty, where nobody is inhabiting that space, or occupied by one household in a particular group. For the purposes of our investigations, we limited the number of groups to two. Vacant space metrics and relative group proportions allowed us to vary the demographics of the neighborhood. Our third parameter of importance gives the criteria for determining if a household is happy or unsatisfied with their currently housing situation based on the demographics of their neighbors. This threshold proportion defines the proportion of neighbors that must be similar to a given household in order for that household to be happy with their space and not want to move. If a household's proportion of neighbors similar to them is below this threshold, then this neighbor will be moved.

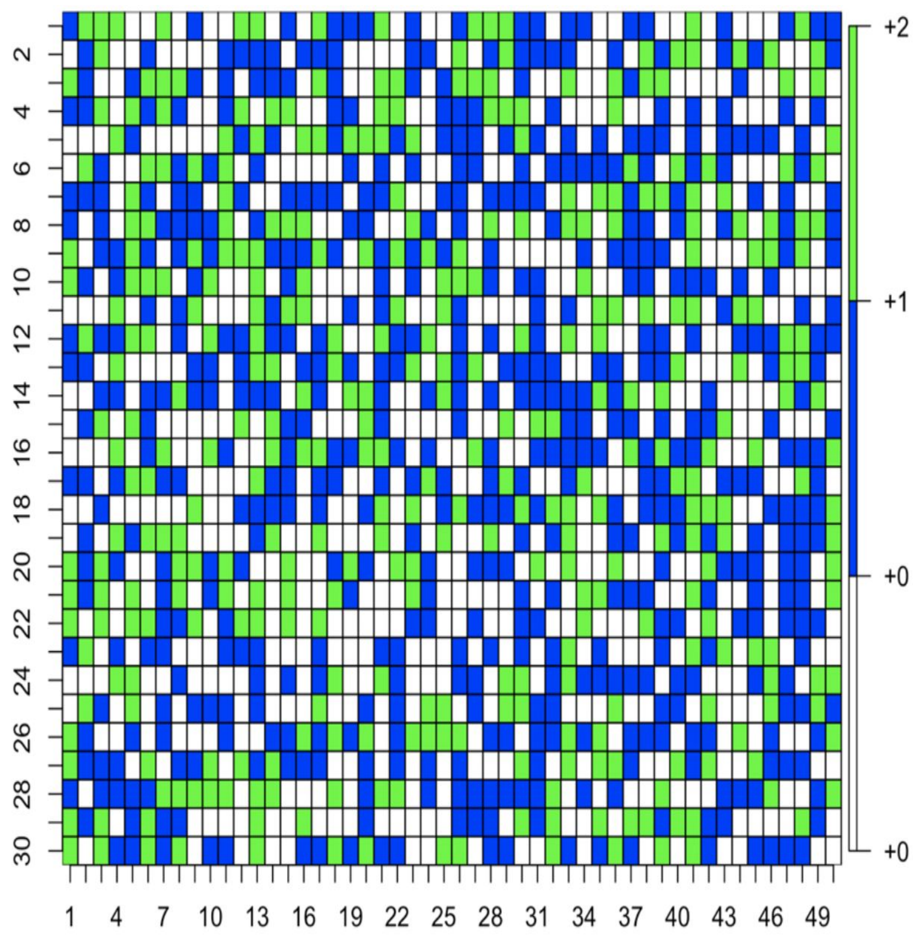
In terms of calculating neighbors, we decided to not have the matrix wrap around, as we wanted to simulate realistic interactions between household members. A household on an edge of a neighborhood is very unlikely to call a household on the far side of the same neighborhood its neighbor; thus, we decided to limit the definition of neighbor to cells immediately surrounding a given household. Further, we did not count empty cells to be neighbors, as an empty cell will not have an impact on a household feeling positively or negatively about its other neighbors.

We created a fairly stochastic process for modeling the moving and evolution of a neighborhood. The construction and initial housing assignments of a neighborhood is based completely on random sampling, limited by the vacancy proportion as well as the number of households in one group in comparison to the other. The evolution of the neighborhood over time was similarly random. One step in the process goes as so: we choose a random non-empty household and calculate the proportion of its neighbors that are similar to that chosen household. If this proportion is greater than or equal to the defined threshold, then the step is complete. If the proportion is less than the threshold, then the household is randomly assigned a new, empty space in the neighborhood. Each simulation we ran performed 100,000 steps, which is what we found to be a point at which behavior of the neighborhood does not change much more even with the addition of more steps.

Results & Conclusions

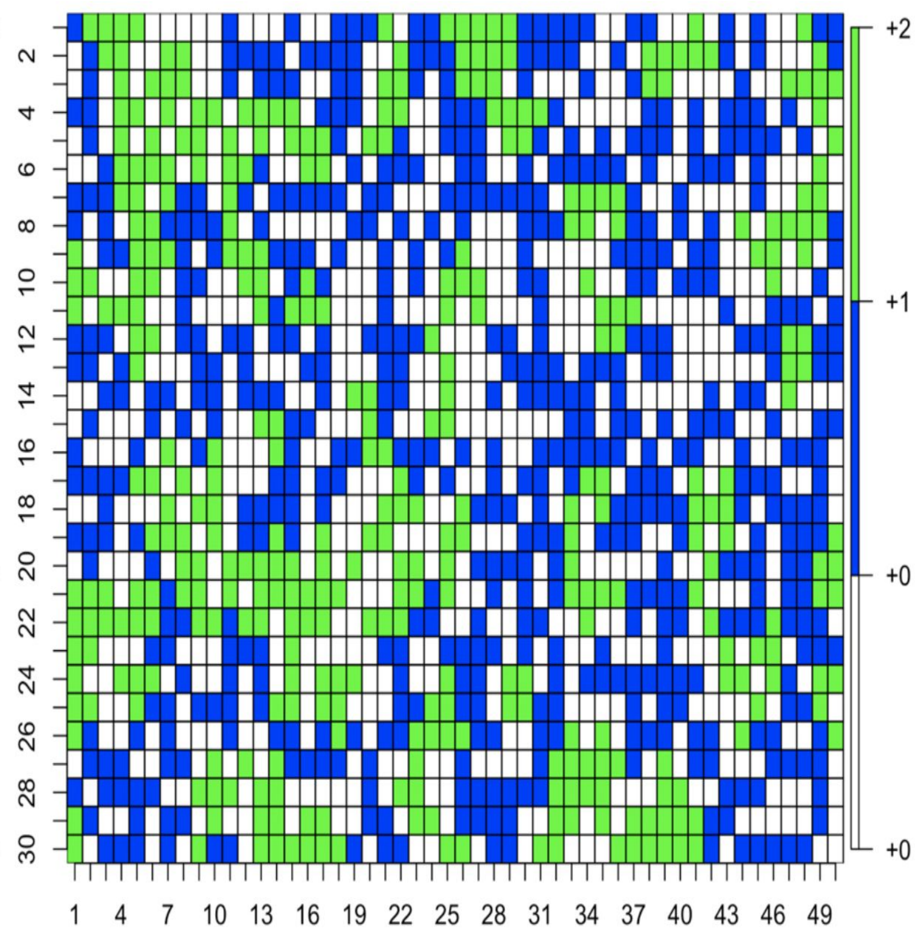
In order to quantify the results of our model, we came up with a segregation statistic that measures the average proportion of people's neighbors that are like them. We measured this value both before running the model, when agents were still randomly assigned to places, and after, when they had been resorted to locations that met their preferences. We ran this model several times, with several different parameters: we varied what proportion of like neighbors people preferred, what the sizes of each group were relative to the other, and what proportion of "blank spaces" there were in the model. What we found was that the proportion size between the two groups did not have a significant effect on the model, which was interesting. An extreme amount of blank space resulted in more segregation, because people were able to move even more, but in most reasonable scenarios it did not have a large effect. Meanwhile, having a threshold of likeness of 30% sameness resulted in a 50% increase in segregation, and a threshold of 60% resulted in a 95% segregation metric. Once you reach a 70% threshold, you are at 99% for the segregation metric, which is nearly double that of the 30% sameness. It is important to note that these numbers are all approximate. In future work, we would be curious in creating a comprehensive simulation that accumulated accurate averages and perhaps could determine the existence of an inflection point of the threshold. Interestingly, extreme likeness thresholds did not result in much segregation; we hypothesize this is potentially because people were simply unable to find places that they were happy.

Results



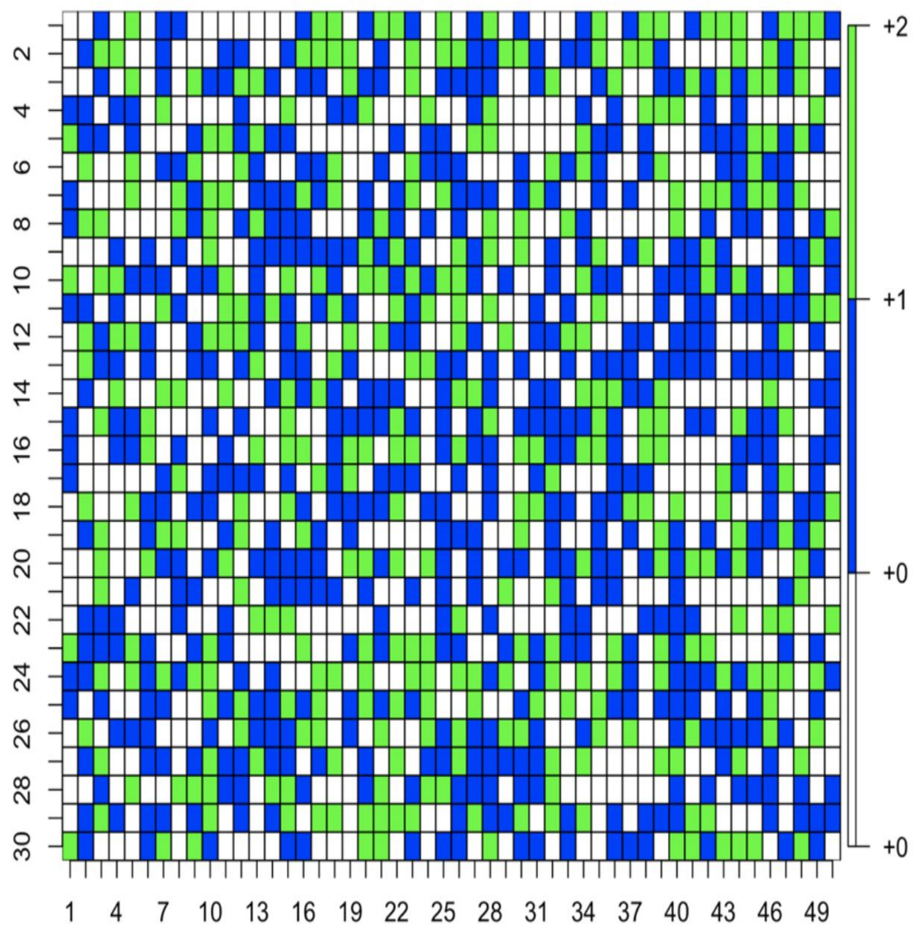
Before Simulating

Randomized model before simulation with 0.3 likeness threshold, 70% blue , 0.4 proportion blank space, and segregation metric of approx. .50.



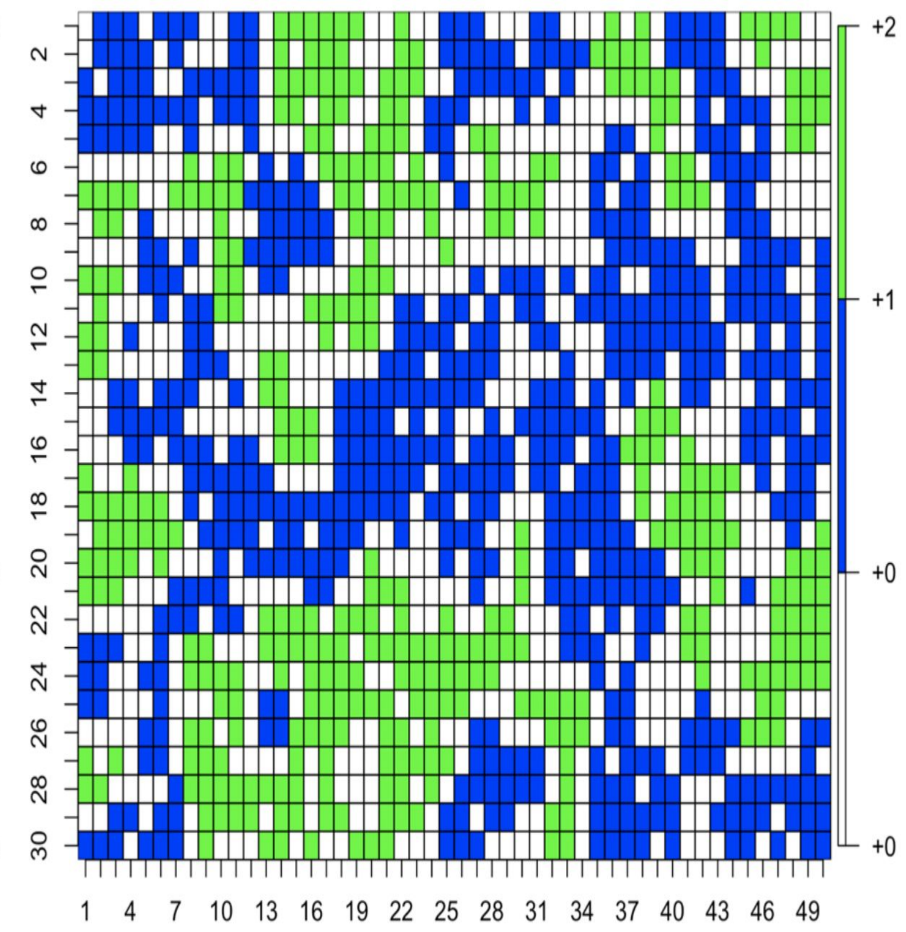
After Simulating

Randomized model after simulation with 0.3 likeness threshold, 70% blue, 0.4 proportion blank space, and a segregation metric of approx. .75.



Before Simulating

Randomized model before simulation with 0.6 likeness threshold, 70% blue , 0.4 proportion blank space, and a segregation metric of approx. .50.



After Simulating

Randomized model after simulation with 0.6 likeness threshold, 70% blue, 0.4 proportion blank space, and a segregation metric of approx. .95.

Further Areas of Possible Research

Given recent sociocultural research into gentrification, we think a further area of research would be to add an economic dimension of how class affects neighborhood diversity. Because race and class are intersectional, we are interested to see how racial displacement correlates to economic displacement regarding urban development. In recent history, we have seen the white flight phenomenon as a response to the "threat" of increasing minority diversity; this is a mechanism of racist and white supremacist systems that underpin American society. Practices such as redlining, rent monopoly, mortgage discrimination, and legal and linguistic barriers are systematic ways in which minority communities are disenfranchised. Schelling writes about the "tipping point" of neighborhoods, and the question of the range of "tipping point" racial tolerance for white Americans is inevitably tied in with the question of the economic "value" of a neighborhood. Using real-life data, we would want to ask how the segregation patterns we see here in this model would vary across neighborhoods that are poor or affluent?

Furthermore, we would definitely be able to modify our model to look at more than two groups of people. Gentrification is unevenly distributed across different racial/ethnic enclaves in urban settings. Because racial dynamics in the United States are not dichotomous, we would also like to look at how introducing additional groups of people with different neighbor preferences would affect segregation and/or integration. In Clark and Fossett's "Understanding the social context of the Schelling segregation model," the authors find that after compiling data of different racial/ethnic group's neighborhood composition preferences, they find that "none of groups has a preference distribution that is compatible with that of any other group." This incompatibility speaks to the complexity of what Clark and Fossett call the "residential mosaic." Thus, we think that incorporating different preference thresholds across interactions between multiple minority groups would be important to examine.