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In this projectt, we provide a comparative analysis of how the defined model with different configurations (type of society, density, moving strategy) behaves and discuss the observed outcomes, highlighting the differences in patterns of segregation or integration. Some of the things in addition to the assignment definition were considered, which are not directly mentioned in the assignment:

- The overall density of the simulation and the composition of the subtypes (light, pale, and dark) were defined by the assignment definition. Since the question does not directly mention the composition of overall blue and red, I assume equal proportion, i.e., the number of the agents according to the density and an equal number of blue and red, where light, blue, and dark within the blue and red were calculated based on the type of society.
- For each of the 3x3x3 = 27 configurations, I use five different runs (each with 1000 iterations at most) and calculate the average from them. Since all runs do not end up in the same number of iterations, I use padding to take the maximum step to calculate the average scores.

Analysis:

1. The satisfaction score

We first look at the average satisfaction scores of all agents for each iteration for all configurations and try to understand how di;erent norms a;ect the satisfaction scores of the agents. Figure 1 presents the average satisfaction scores for three di;erent societies under di;erent configurations. To answer, ***"How do di(erent norms influence individual agents' satisfaction and society's overall satisfaction?",*** we observe Figure 1 and highlight a few insights:

- In a **Dense** population, the average satisfaction score in an **Intolerant society** is higher than in a neutral or tolerant society. The reason can be explained by the number of dark agents in a dense population, which is higher in proportion and number. The tolerance of dark agents is small; hence, more agents (dark) are looking to move to less diverse places, and the chances of being in similar surroundings are higher in dense populations with similar types or subtypes. As a result, the overall satisfaction increases. This can also be explained when we see the initial and final state of the society in a Tolerant vs Intolerant Society. Figure 2 shows that in an intolerant society, in the final state, darker colors are more segregated to be with similar subtypes and types, which results in more satisfaction.
- In general, the satisfaction scores are consistently higher with the "**Nearest Higher Satisfaction**" movement strategy. Although from Figure 1, we can see the steps are typically higher in this strategy because the algorithm is always searching for higher satisfaction with small increments. Still, the overall results converge to a higher satisfaction score.

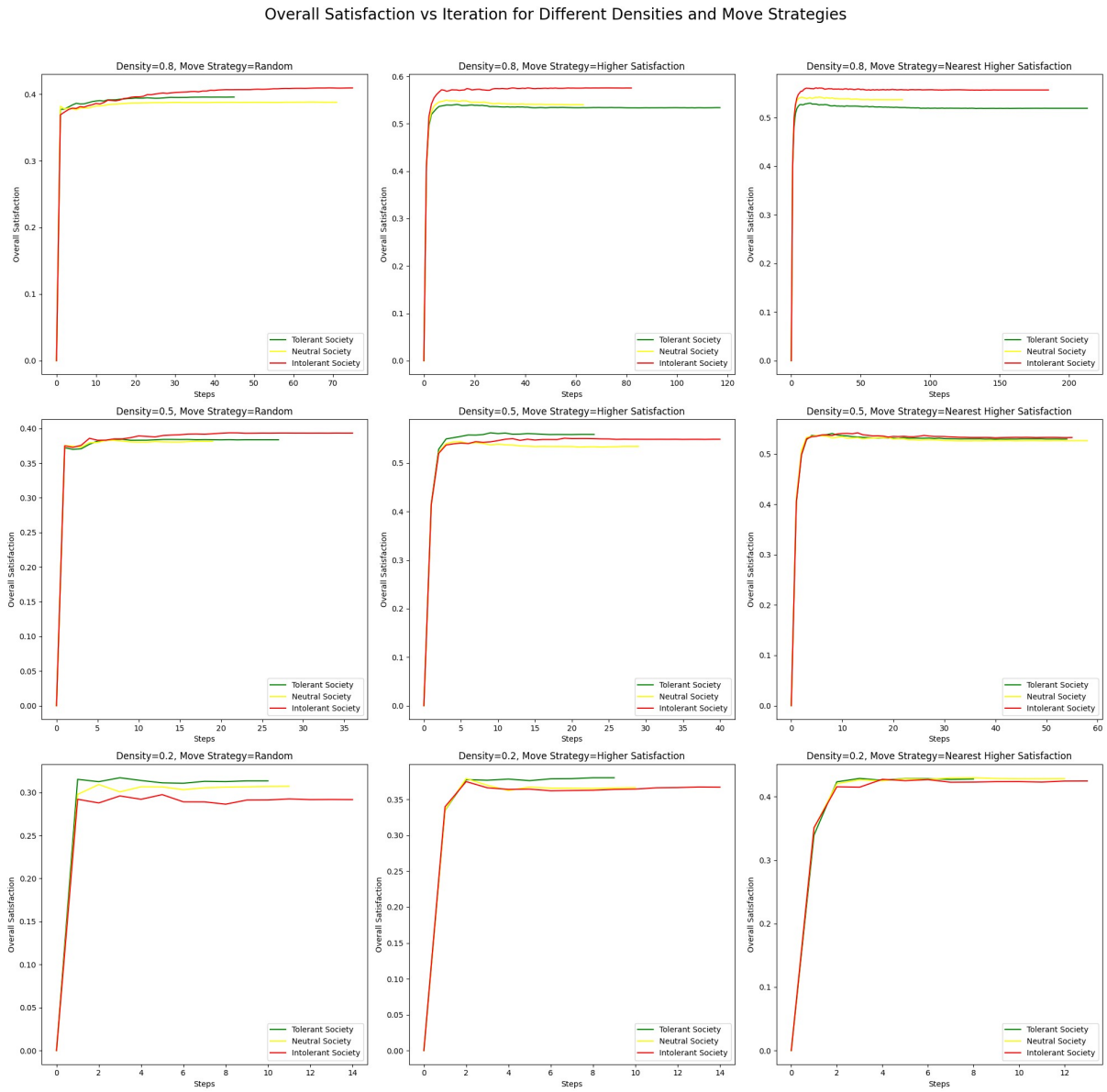
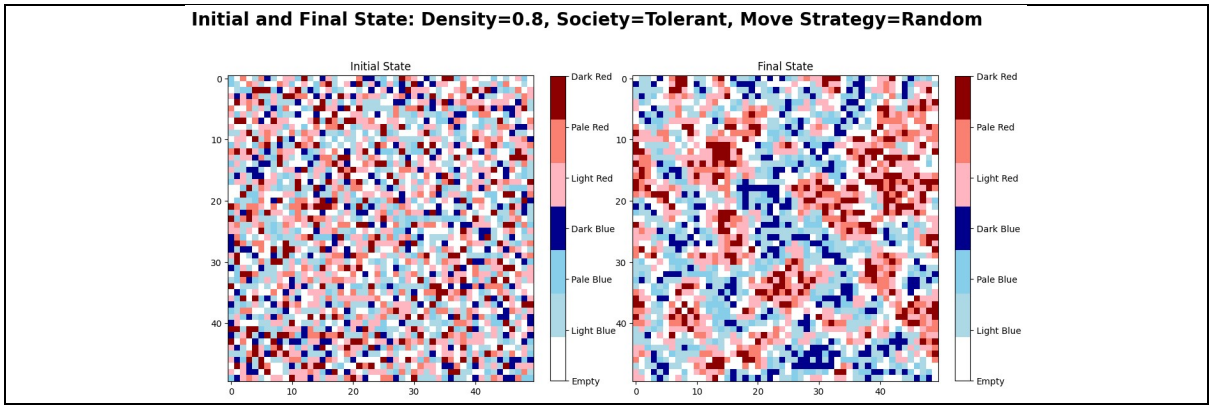


Figure 1: Satisfaction scores for Agents

To answer, **"*Does satisfaction depend on the population density?*",** we can again look at Figure 1 and notice that when population density decreases, the average satisfaction scores also decrease because there are fewer agents of similar subtypes to be with.



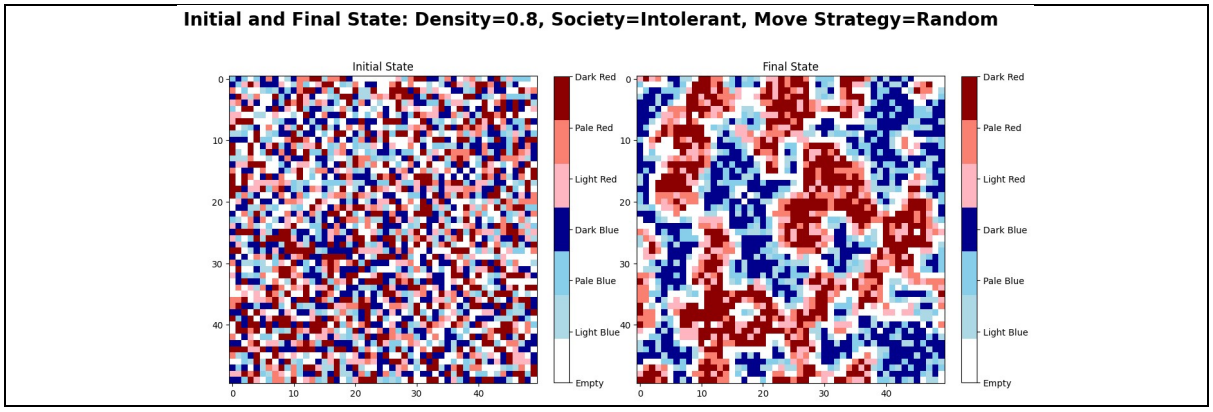


Figure 2: Tolerant vs Intolerant Society

We can also look at the number of satisfied agents in the final state for di;erent configurations in Figure 3.

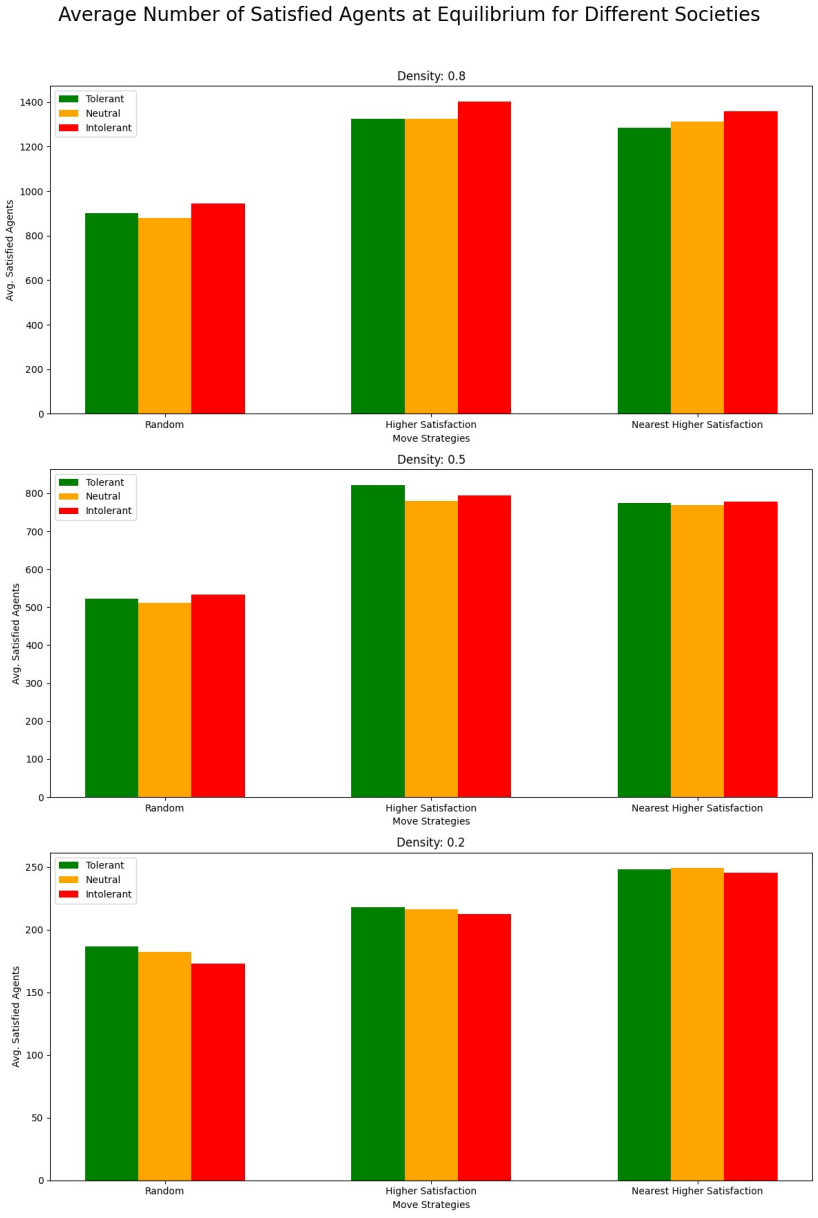


Figure 3: Number of satisfied agents

Figure 3 clearly shows that satisfied agents decrease when density decreases, confirming our hypothesis.

We also want to explore the satisfaction score by subtypes further to get more insight into the e;ect of norms. Figure 4 shows clearly that in a tolerant society, tolerant agents have the highest satisfaction regardless of density as they are high in number in this type of society. Additionally, the intolerant agents have a variable satisfaction score with density. When society is Dense, their average satisfaction scores exceed the neutral agents, as they tend to move to higher satisfied locations. In a sparse society, their satisfaction is the lowest as there are not enough intolerant agents. On the contrary, if we look at Figure 5, we see completely opposite characteristics, as the intolerant agents tend to have higher satisfaction scores.

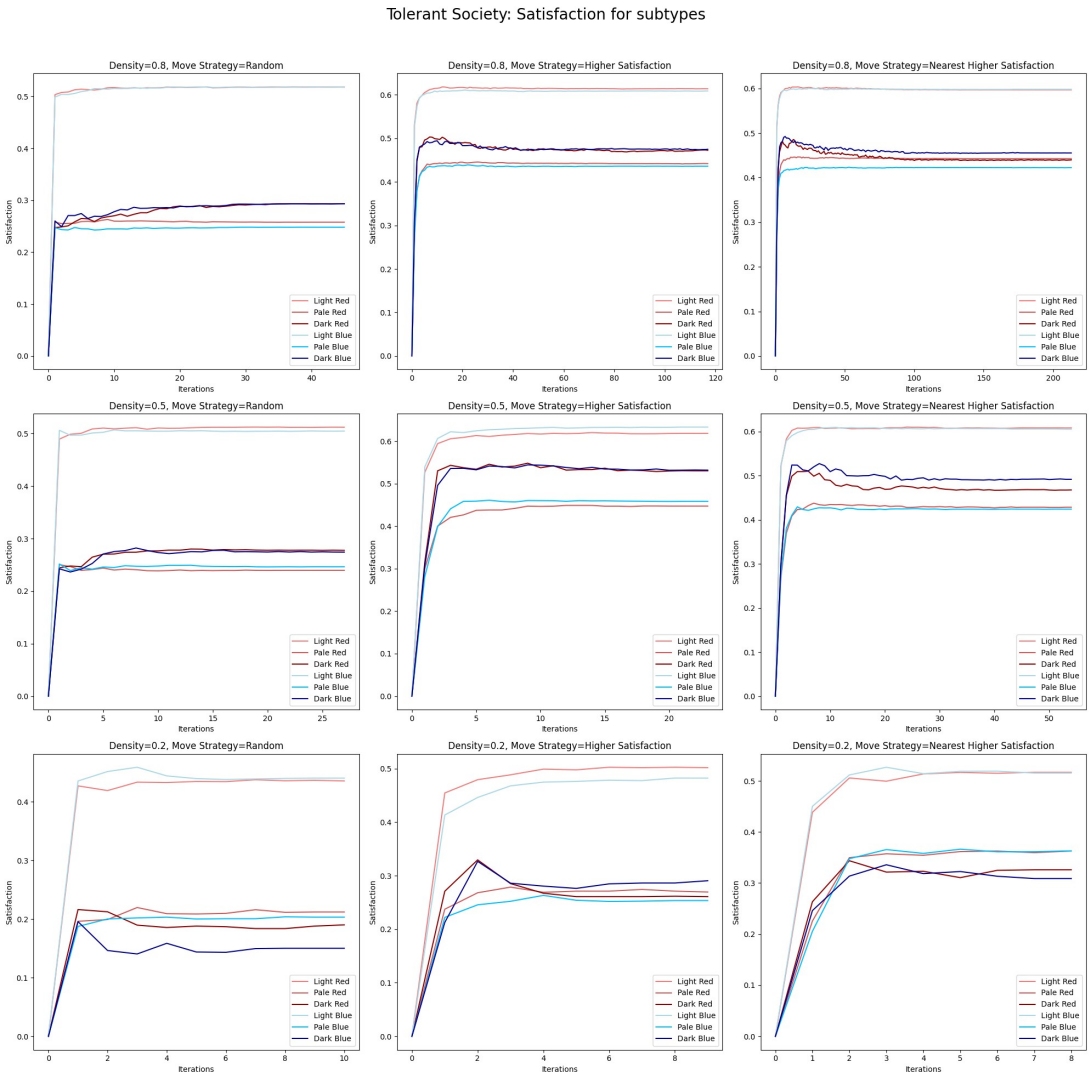


Figure 4: Satisfaction scores for subtypes in Tolerant Society

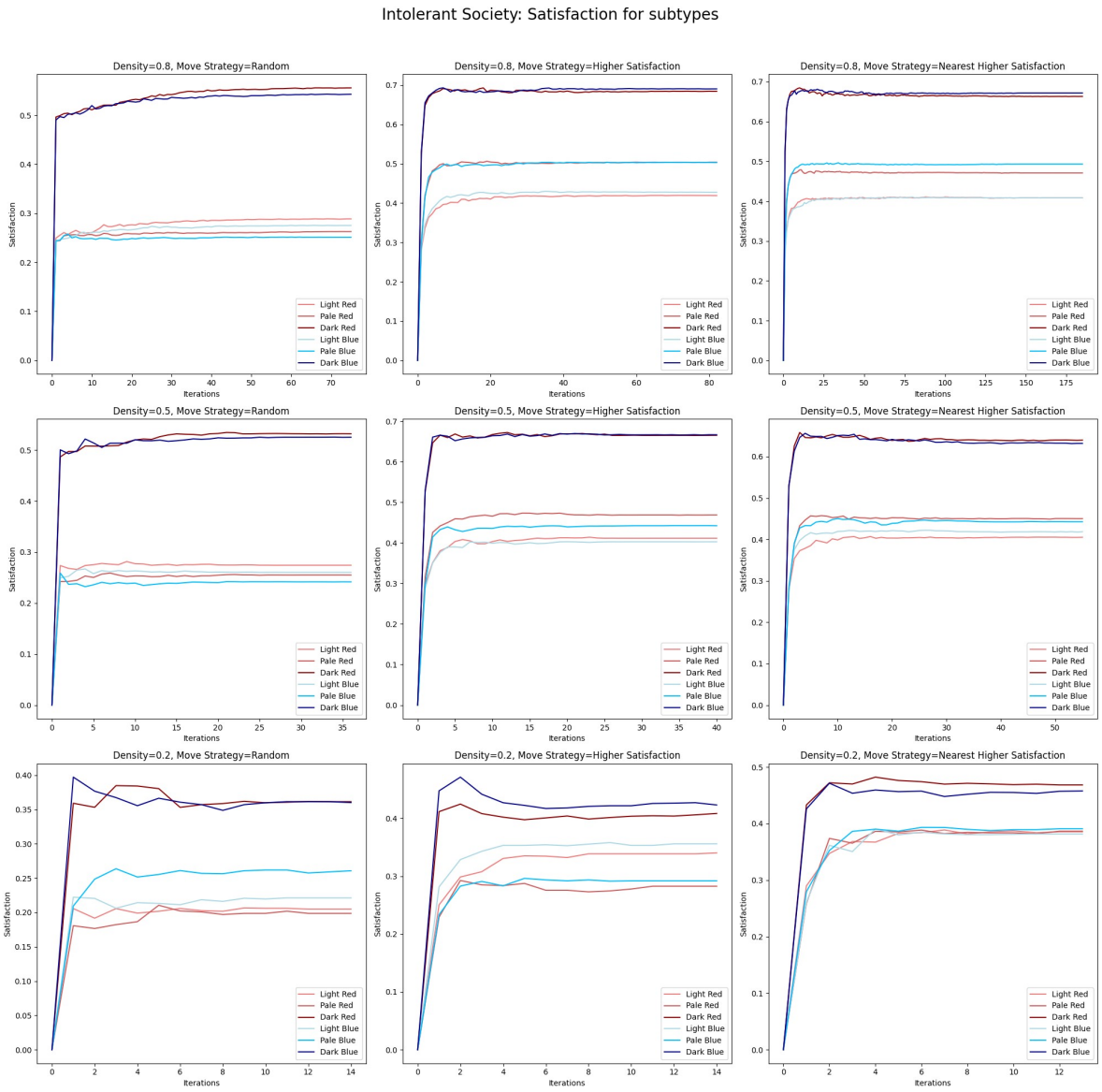


Figure 5: Satisfaction scores for subtypes in Intolerant Society

2. The homophily

- We exhibit the overall homophily in Figure 6. We can see that in an intolerant society, the homophily goes down lower than in a tolerant or neutral society. We have already seen that the intolerant agents in an intolerant society tend to stay together, making larger clusters (compared to other society types). This results in a lower diversity for those agents, which results in a lower homophily.
- For density, we can see that the di;erence in homophily is more significant for the Dense population in di;erent societies than in sparse societies. This also ties back to the fact that in a dense society, the clusters of intolerant agents are more significant, resulting in lesser diversity for each. So, the homophily is less.

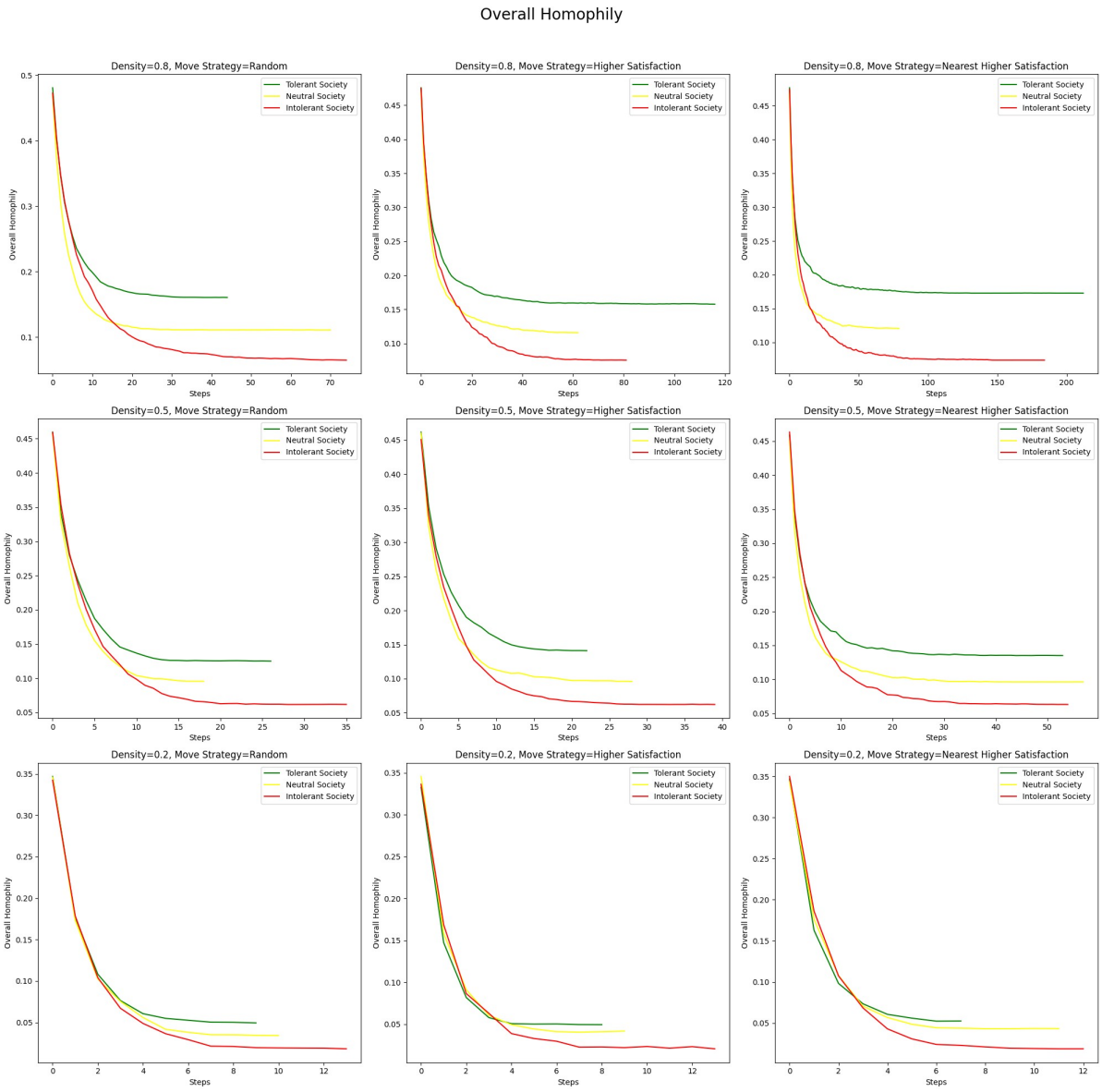
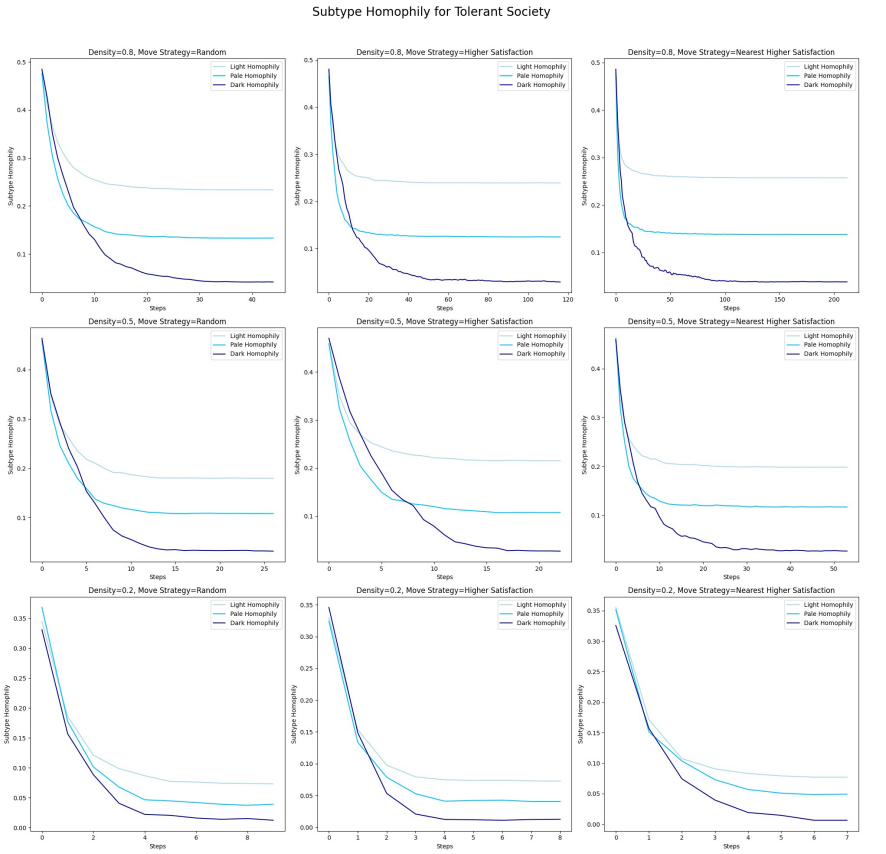


Figure 6: Overall homophily

If we look at the homophily for subtypes, Figure 7 for the tolerant and intolerant societies. Respectively, we see that homophily is always lower for intolerant agents regardless of the population density, as the intolerant agents are the first ones to move to similar subtypes, resulting in a less diverse environment.



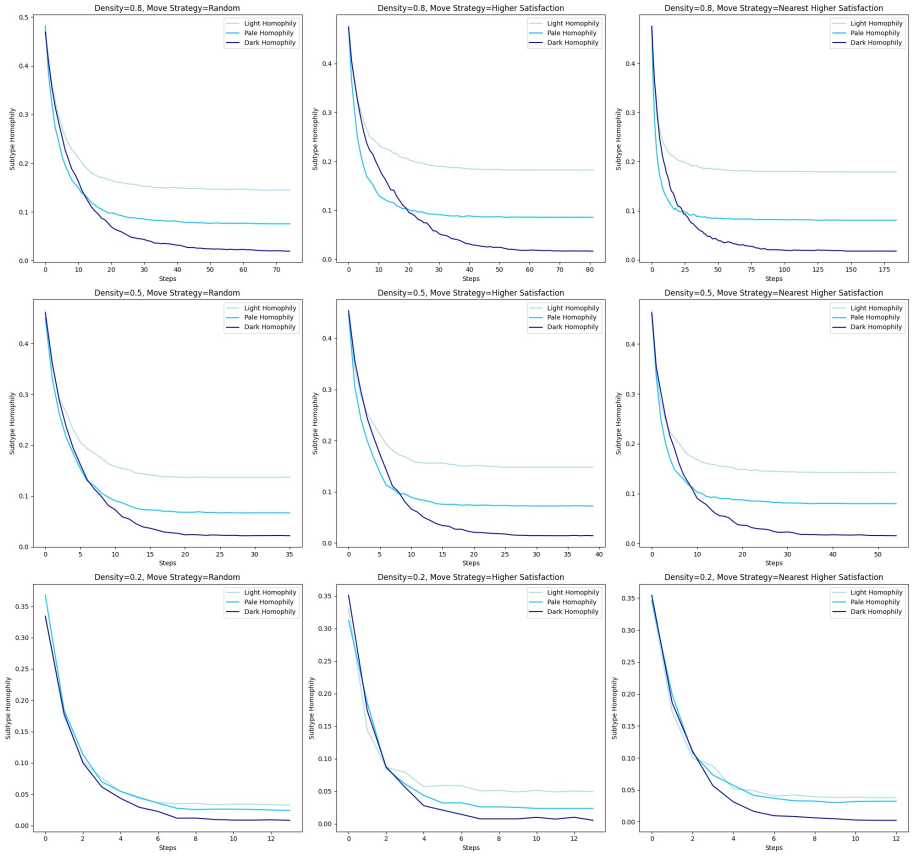


Figure 7: Subtype homophily

3. Final Distribution of agents

We take a dense population in a tolerant society as an example to explain the segregation characteristics in Figure 8. We can see that in the 'Random' strategy, the clusters are loose, and segregation is not strong, as the relocations are random. On the other hand, in the 'Random Cell with Higher Satisfaction,' segregation is stronger than random, as it looks for a similar subtype resulting in higher satisfaction. However, there are still overlaps of subtypes of a type in clusters as the relocated position was chosen at random. Finally, the 'Nearest Cell with Higher Satisfaction' gives a more defined local segregation surrounded by similar type and subtype as it goes to the nearest location of higher satisfaction.

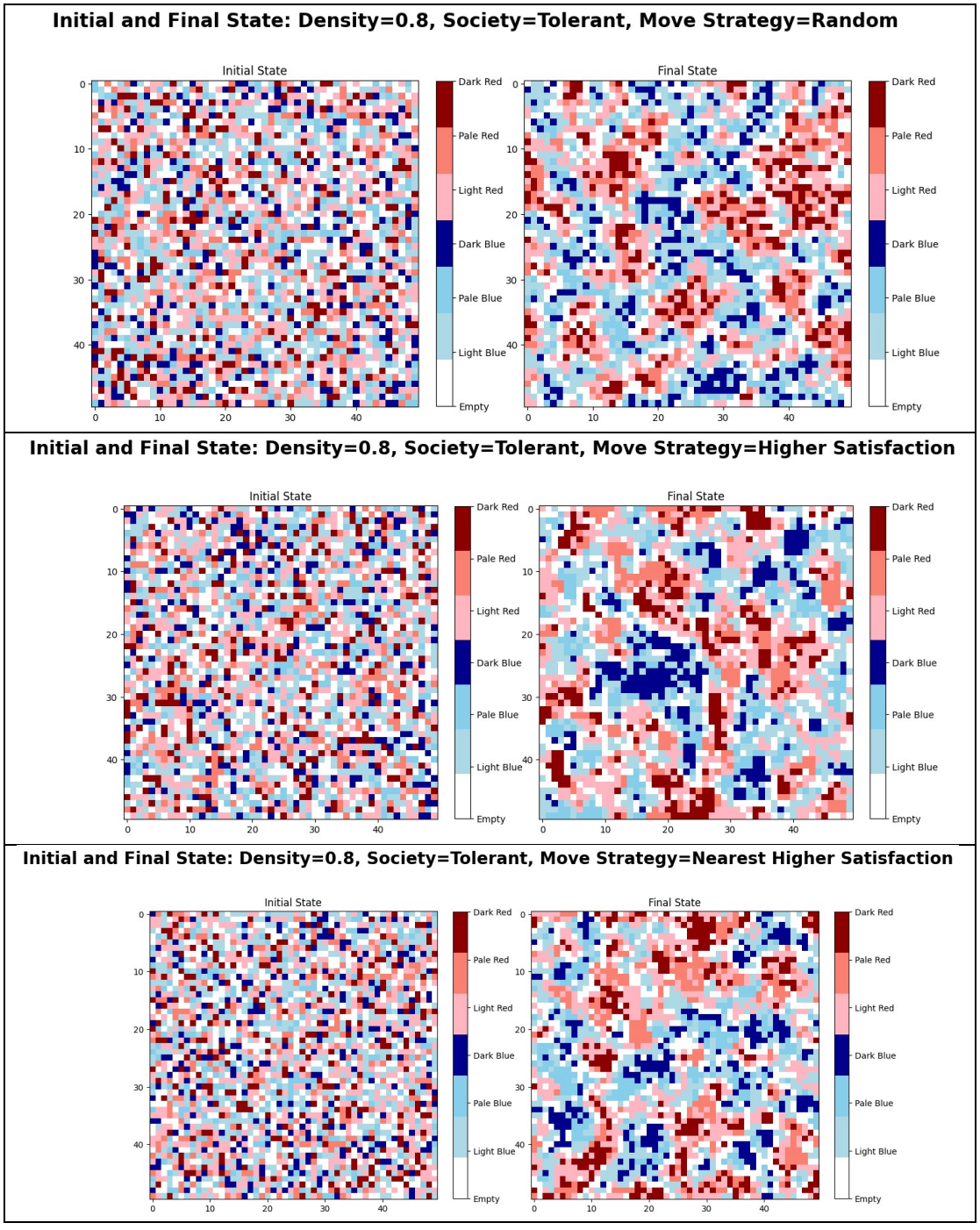


Figure 8: Segregation pattern

4. Corner and Edge Agents

Corner and edge agents have fewer neighbors than the middle agents. As a result, a minor dissimilarity with its neighbors can lead to significant diversity in the move. On the other hand, slight dissimilarity can also result in lower satisfaction, making the corner and agents sensitive to movements. If we look at Figure 9, it is evident that corner and edge agents are facing volatility until equilibrium compared to the middle agents, which confirms our hypothesis. Similar fluctuations in satisfaction can be noticed in Figure 10. Small changes result in huge fluctuation of satisfaction for corner and edge agents in comparison to middle agents.

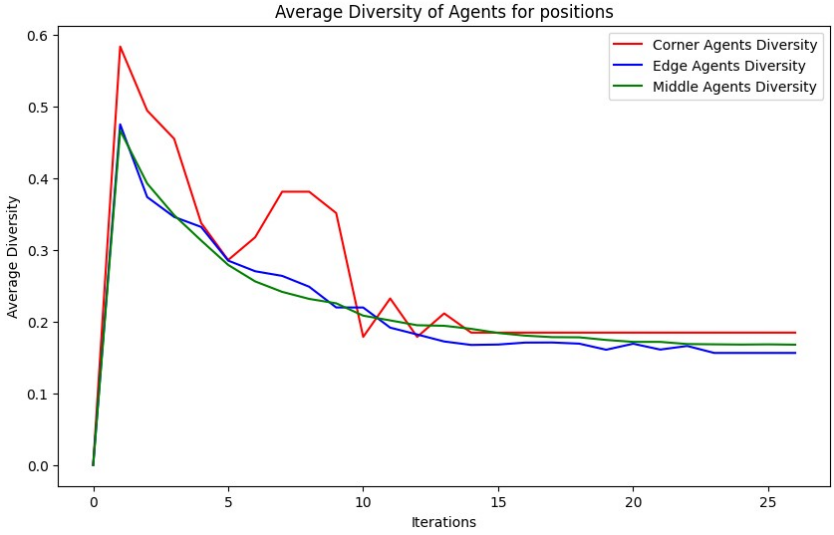


Figure 9: Average diversity of agents for position

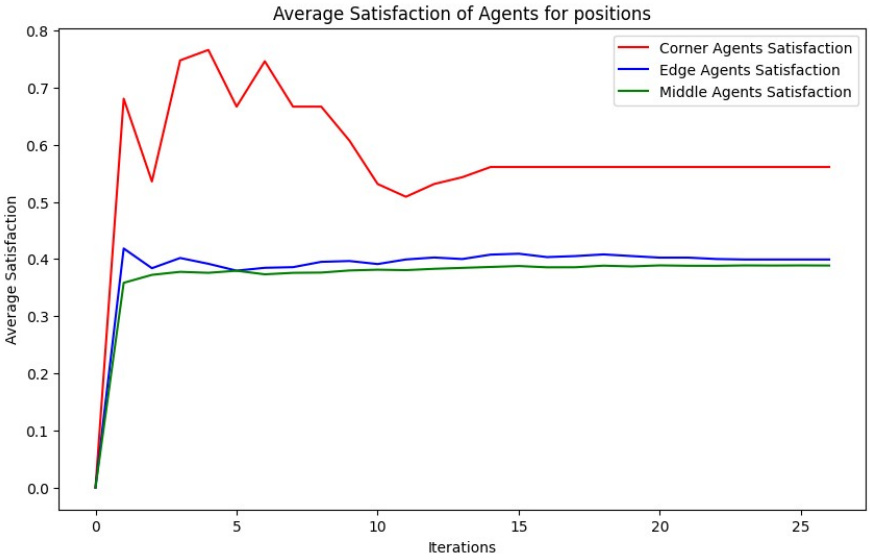


Figure 10: Average satisfaction of agents for position

Note: Some of the codes were debugged using ChatGPT. No text or explanation was taken from ChatGPT.

References

OpenAI. (2024). ChatGPT [Large language model]. https://chat.openai.com/chat