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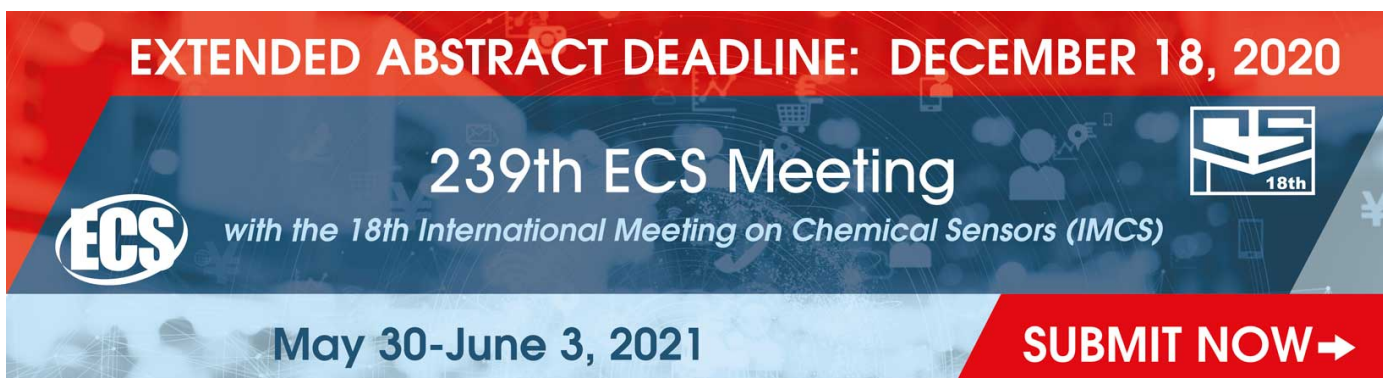
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Analysis of the Causes and Solutions of Apartheid Based on Schelling Model with Welfare Policy

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Abstract: In recent years, with the widespread dissemination of the concept of anti-racial discrimination, various countries have introduced a series of welfare policies for ethnic minorities, trying to control population apartheid to alleviate the generation of racial conflicts, and many achievements have been made. However, apartheid seems to have rebounded recently. This paper proposes the Schelling model with welfare policies to analyze the reasons for the rebound phenomenon and propose possible solutions.

1. Research background

Since May 2020, due to the outbreak of ethnic conflicts in many parts of the world, many social problems have been caused, and the achievements in breaking apartheid are in danger. The New York University magazine "Washington Square News" recently reported that New York University plans to build an isolated residential area only open to "black students and black resident assistants" by the fall of 2021. It is very important to propose a solution to alleviate this problem.

Ethnic conflict will lead to the emergence of apartheid, and apartheid will aggravate the ethnic conflict. Therefore, resolving the issue of apartheid can greatly improve ethnic conflicts and reduce the resulting social problems.

Through Thomas Schelling's apartheid model and the conclusion of game theory, we can know that if there is no manager's participation, even if everyone tends to a social state of even racial distribution, apartheid still exists. However, Schelling's model is no longer applicable when the government is involved in providing welfare to the people.

To explain why even countries with preferential policies for ethnic minorities still have the imagination of apartheid, based on Schelling's model, it is important to increase the welfare policies mechanism, observe the relationship between the types of welfare policies and the final result, and find a welfare policy that makes the final result more inclined to a social state with even ethnic distribution.

2. Schelling isolation model

The Schelling model is a famous model invented by American economist Thomas Schelling. By observing the result of where people choose to live, will reveal the reasons for apartheid.

2.1. Agent-Based Simulation

The Schelling model is an Agent-based simulation, in which everyone in the model has their decision-making method, the interaction between decisions, and finally observes the overall changes.

In Schelling's model, the agents are residents. Each agent decides whether to move based on the proportion of people around with the same skin color. Finally, observe the whole to determine whether



apartheid exists.

2.2. Schelling isolation model simulation

First, simulate the Schelling model and observe the results.

We assume that there are two kinds of people in a town, namely, red-skinned people and blue-skinned people. There are a total of 1,900 people, of which 1,400 are red-skinned people and only 500 are blue-skinned people.

Initially, they were randomly assigned residences. Then, the residents will decide whether to move based on whether they are satisfied with the living environment. After many relocations, we will get a result that all residents are satisfied with.

People's satisfaction (s) is related to the proportion (p) of people with the same skin color in the surrounding people.

$$s(p) = \begin{cases} \frac{1}{thd} * p & \text{where } x < thd \\ \frac{1}{2} * \frac{p+thd-2}{a-1} & \text{where } thd < x < 1 \end{cases} \quad (1)$$

Where thd is the proportion of the same skin color that everyone expects most. Everyone's thd is different and obeys a normal distribution with an average of 0.5.

When $s(p) < s(1-p)$, the resident will choose to move because he is not satisfied with the living environment.

The simulation results are satisfactory to all residents, as shown in Figure 1.

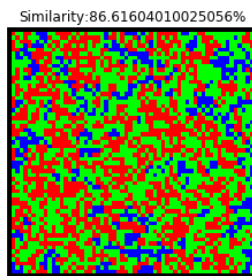


Figure 1 Schelling model results

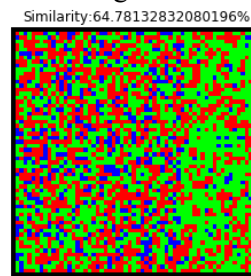


Figure 2 Schelling model results with welfare policy

As can be seen from the figure, the red-skinned race and the blue-skinned race are relatively isolated. Observing the ethnic similarity of everyone in the town, we can conclude that the average similarity in the town is 86%, not the 50% expected by most residents. This is something that the managers of the town did not expect.

2.3. Results under different thd

In 2.2, it has been verified that if thd conforms to a normal distribution, apartheid will occur. To find the reasons for apartheid, several ideal environments were continued to be simulated.

Assuming that people in the city have the same thd , observe the result that all residents are satisfied when $thd = 0.3 + 0.1k$ ($k = 1,2,3,4,5,6$). Record the average similarity under each result. The result is shown in Figure 3.

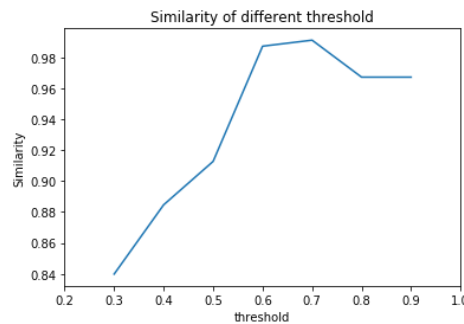


Figure 3 Average similarity under each thd (without welfare policy)

It is not difficult to see that even if urban residents are very tolerant (thd = 0.3), the average similarity of the final results is still 84%.

2.4. Summary

Through the above simulation results, we can conclude that no matter what the proportion of people with the same skin color that residents most expect, the result will lead to apartheid.

3. Schelling model with welfare policy

Because the residents cannot solve the phenomenon of apartheid by themselves, to solve the phenomenon of ethnic apartheid, the managers must do something to change the relationship between residents' satisfaction and proportion.

The most used method is the reward mechanism. We give certain rewards to urban residents to increase their satisfaction and eliminate dissatisfaction with the living environment.

Specifically, it is divided into two models: The Complete Reward Model (welfare society) and the Minority Groups Reward Model.

3.1. Complete Reward Model (welfare society)

The Complete Reward Model refers to the provision of welfare to all residents whose proportions have not reached the expected value based on the original model to improve their satisfaction. The relationship between welfare (R) and proportion(p) is as follows:

$$R(p) = \begin{cases} thd - p & \text{where } p < thd \\ -(1 - p) * (thd - p) & \text{where } thd < p < 1 \end{cases} \quad (2)$$

Residents will judge whether they are satisfied with the living environment based on s(p) and R(p) to choose whether to move.

Similarly, if the residents have the same thd, when all residents meet thd = 0.3 + 0.1k (k = 1,2,3,4,5,6), observe the average similarity of the town. The result is shown in Figure 4.

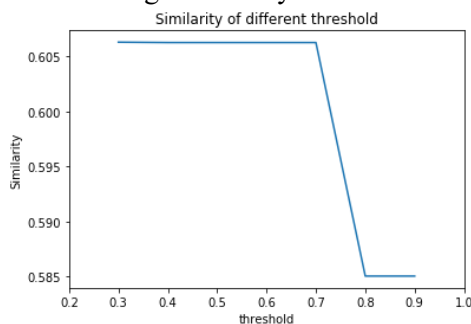


Figure 4 Complete Reward Model results

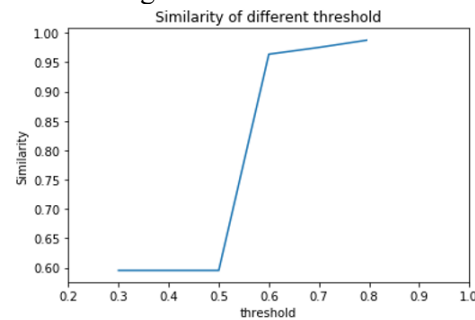


Figure 5 Minority Groups Reward Model results

In the Complete Reward Model, the final average similarity is in the range of 50-60%, which is a good result.

However, this model has many disadvantages. First of all, this is ideal. It is difficult for us to accurately know the true psychological expectation value thd of each resident.

At the same time, to maintain this result, managers may need to spend a lot of money to distribute benefits to everyone, so this model is also called the social welfare model.

This shows that if the welfare conditions of a society are very good, people will tend to stay here and will not care about the ethnic groups of the people around them.

3.2. Minority Groups Reward Model

Another model is that in some places where only minorities ($p < 0.5$) are provided with welfare, the majority will reduce their satisfaction because they are dissatisfied with the minorities' welfare.

The relationship between welfare (R) and proportion(p) is as follows:

$$R(p) = \begin{cases} thd' - p & \text{where } p < thd' \\ -(1 - p) * (thd' - p) & \text{where } thd' < p < 1 \end{cases} \quad (3)$$

Where thd' is the ideal proportion in the minds of managers, so we take 0.5.

Similarly, perform a simulation. The result is shown in Figure 5.

Among them, because it is impossible to find satisfactory conditions for all residents when thd = 0.9, it is ignored. It is not difficult to see that in an ideal environment when thd is less than 0.5, the Minority Groups Reward Model is very effective. However, once residents only have a slight tendency to apartheid, the final degree of apartheid will immediately rise to the extreme.

Observe the result when thd conforms to a normal distribution with an average of 0.5. The result is shown in Figure 2.

Although the result did not reach the ideal 50%, 64% can still be regarded as a relatively evenly distributed result. Therefore, it can be considered that the Minority Groups Reward Model is still useful under a normal distribution with an average of 0.5.

3.3. Summary

In this section, we analyze the simulation results of two welfare models.

Although the Complete Reward Model is expensive, it can achieve the goal of eliminating apartheid in various situations.

When urban residents do not tend to apartheid, the Minority Groups Reward Model is very effective, but once there is a tendency to apartheid, it will have a huge reaction.

But in general, if the residents on average do not tend to apartheid, then the Minority Groups Reward Model is still useful.

Therefore, it can be concluded that to distribute ethnic groups as evenly as possible, if the resident does not tend to apartheid on average, then the Minority Groups Reward Model can be adopted. If there is a tendency for apartheid, the Complete Reward Model should be adopted.

4. Reasons and solutions for the backlash of apartheid

According to 2.4 and 3.3, we can draw the conclusion shown in Table 1.

Table 1. The relationship between welfare policy and apartheid

	No welfare policy	Minority Groups Reward Model	Complete Reward Model
Tendency to apartheid	Apartheid	Apartheid	No apartheid
No tendency to apartheid	Apartheid	No apartheid	No apartheid

4.1. The reason of backlash

In the case of Minority Groups Reward Model, apartheid still occurs. It can be inferred from Table 1 that the reason is that residents tend to apartheid.

4.2. Feasible solution

According to Table 1, in the case of racial apartheid among residents, in order to avoid apartheid, the Complete Reward Model should be adopted.

Of course, since it is unrealistic to consider the thd of each person, it can be divided into areas, calculate the average value of thd in each area, and then distribute the income according to the average thd and p of the area.

Different regional welfare policies will promote the flow of residents between different regions to achieve their desired satisfaction and ultimately restore the similarity to about 50%.

Then calculate the average thd of residents at regular intervals, and after the average thd drops below 0.5, re-adopt the Minority Groups Reward Model.

5. Conclusion

This article first demonstrates through the simulation of the Schelling model that without the participation of managers, no matter what the ideal living environment in the minds of residents is, apartheid will occur.

Subsequently, two commonly used welfare models were simulated, namely the Minority Groups Reward Model and the Complete Reward Model.

This article also proves that when the residents do not tend to apartheid on average, it is effective to adopt the Minority Groups Reward Model to maintain the even distribution of races. Instead, a Complete Reward Model should be adopted.

For those who have adopted the minority welfare model but still have apartheid, the solution given is to temporarily adopt the Complete Reward Model and re-use the Minority Groups Reward Model after the trend of apartheid slows down.

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