CONNECTING COMPUTATION TO URBAN SOCIAL SYSTEM

An Application of Agent-Based Model on Simulations of the favela

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Abstract. The complexity of urban social system makes it difficult to be computerized. The trend of simplification has always existed in understanding and modelling the city. However, this enlarges the gap between the planned or designed urban and the real operations of the city. This research focuses on the Favela to study the general principles of the social system and is doing an attempt to computerize the Favela. Agent-based Model is applied in this research and has been developed by involving more groups of agents, imitating multiple social systems. The interactions among different systems in computation are based on initial sociological studies. The computational model can be understood as a preliminary study of computerized social system.

Keywords. City; self-organization; Favela; agent-based model; urban.

1. Introduction

It is difficult to simulate details of urban social systems computationally due to its hyper complexity. The trend of simplification often happens in modelling which affects the understanding of architecture and the urban as well as designs. What has been hidden by simplification could have led a transformative perspective on architecture, urban and design. To study the complexity of the city would be a significant step. Social systems are especially important for the city as the latter could be understood as a container or product of human society. Nowadays, the power of the Internet has been rising and the trend of self-organization is taking over hierarchical social systems. It is more inextricably linked of the development of the social system, social relations and the city. Global changes of the city are obviously influenced by controls from the bottom- disorderly and numerously. In computation, the agent-based model (ABM) developed from generative algorithms provides the possibility to model complexities. Agent-based model is a class of computational models for simulating interactions and actions of autonomous agents. It is frequently used in the study of sociology and the modeling of organizations. Operations are on individuals or agents, but the
aim is to access their influences on the whole system. It is further developed in this research by applying principles of urban social systems equivalently to computation. In this case, additional groups of agents were added to explore the external influences of a self-organizing system. The external and internal interactions were proved to be both significant for the formation of the urban social system.

Self-organization system taken as a focus, the Favela was chosen as the study sample. Favela refers to slums in Brazil, the form of which is highly reconciled with the form of sociology. The first Favela, now known as Providência in the center of Rio de Janeiro, first emerged in the 19th century. It was started by a group of soldiers who had no place to live in after the Canudos War. Favela is a word from the name of a hill they got familiar with during the war they participated. They used it to call the slums they built. The diversity of residents is a significant evidence for the complexity of the Favela. Transformation of residents continuously happen in it. In fact, the Favelas appeared early than the dense occupation of cities and the domination of real estate interests. Low-income families started to live in a situation like that in 1920s. In 1930s, the Building Code first recognized their existence and marked the beginning of explicit favela policies. Later, the housing crisis in the 1940s and the politician Getúlio Vargas’s industrialization both drives more people into shantytowns. The favela expanded beyond Rio and into the metropolitan periphery. During the last century, the favela served for the inopportune citizens of each era. People affected by war, industrialization, poor economy found themselves in the favela. Even, drug traffickers found it a place beneficial for their business. They stayed there and affected this area deeply. This research is focusing on the period when drug traffickers are dominating the favela- from 1980s till now. Before this there were many failed attempts to improve water and electricity services, sanitation conditions, garbage collection situations and other aspects that affects the quality of life in the favela. The favela has been dominated by drug trade and violence since then. Original residents didn’t escape but found symbiosis with drug traffickers. In 1995, the state approved a joint army-police intervention called “Operação Rio”. It was the state’s attempt to regain control of the favela from the drug traffickers. The three prominent controls appeared to be drug traffickers, original residents and the police. The situation continued a long time and is still existing in some areas of the favela.

The simulation of the favela is focusing on social interactions. Analog principles are extracted from behaviors of the three prominent control groups and have been converted to kinetic principles. The aim of this attempt is to explore the possibility of simulating complexities of the urban. The result of it drew inseparable importance of external influences as the same as internal interactions in a self-organizing urban system.
2. Principles underneath the complexity

2.1. IDENTIFICATION AND SOCIAL INTERACTIONS

Underneath the instabiliy of the society, identification is a motivation for changes. As a human instinct, it is recognized with repetitive behaviors and mimicry. From the study of social behaviors and interactions of the favela, it is found out that identification is playing a significant role underneath social behaviors and interactions. Drug traffickers are treated as outsiders by original residents, and once a resident turned to drug trading, he is an outsider too. They produce violence to build their authority and maintain their business. And producing violence became the way of identifying themselves as drug traffickers. In other words, social changes can be coded with identification which can be further coded with repetitive behaviors. Furthermore, the behaviors are topological as they follow the rules of mimicry. Here, mimicry indicates the concept Neil Leach illuminated in Camouflage, referring to human behaviors, it includes the mimic of nature and the copy of others’ behaviors. Behaviors of each person are slightly different but are connected by copying and mimicking. This could explain the process of identification changing. When one changes from a resident to a drug trafficker, what he does is to discard repeating the behaviors of the residents but copy the behaviors of drug traffickers. It could be connected to agent-based model as the latter is about topological behaviors of homogeneous agents. Aiming to involve more complexity, this research was not limited to studies on internal interactions of a social group but turned to the external influences and interactions between different groups.

2.2. PROMINENT RELATIONSHIPS IN THE FAVELA

2.2.1. Drug traffickers and residents

Financial interest is the original and the main factor that influences the behaviors of drug smuggler. As foreigners, they take control of Favela by establishing an authority which is achieved using violence and weapons. They have the power to suppress confictions among residents and keep the area peaceful and stable. However, the governing does not rely on laws or principles and they make judgments according to their own interests. The violence in their hands also exposes residents to danger when they lose control of it, for example, they shoot domesticated animals of prestigious people. Such “non-human” actions are parts of the establishment of their authority. Therefore, it leads drug traffickers to have dual roles of protection and violation towards original residents.

Those residents who have close relationship with drug traffickers can protect themselves in a local confliction but also exposes themselves to violation. So, they want to maintain “appropriate intimacy” with drug traffickers - neither too close nor too far. They expect a drug trafficker to be the son of their neighbors or relatives, but not theirs. This aptly revealed the interconnected and opposite relationship between the two groups. But the existence of drug traffickers is still meaningful. Violence still exists even if there are no drug traffickers and not only, they bring in new violence but also represses violence among themselves. In contrast to the two kinds of violence, residents have resistance and react to
the violence brought about by drug traffickers - if the new violence exceeds the original ones, then it will trigger a boycott. This resistance usually occurs from external forces, the police, for example. Drug traffickers are quite aware of this and therefore, the balance can be maintained.

Inside of the system of drug dealers, the hierarchy is obvious. Higher status means more privilege, higher authority, and more economic interests. Conflicts happen when one has more demands or higher desires. And inside of the system of residents, the tight bonding with drug traffickers is a symbol of having more privilege. Although they are under two mechanisms, they influence each other in a bottom-up way. For instance, sometimes a drug trafficker fights for higher status in order to provide better protection for his relatives or family who are normal residents. In that way, one system is affected by bottom-up forces from another system. The complex interactions of two systems could be simplified to simple operations on individuals.

2.2.2. The police and the residents

The police are also recognized as outsiders for residents of Favela. They are against the drug traffickers’ group and so they sometimes show intimacy with the residents to get information about those. Residents sway between drug traffickers and the police. In some cases, if residents who are addicted to drugs and couldn’t pay off their debts, may collaborate with the police and disclose drug traffickers. However, they keep silent and stay away from the conflicts between the police and drug traffickers in most of the time. Residents are swaying between drug traffickers and the police, sometimes biased towards drug traffickers, and sometimes towards the police - depending on their own interests. In the same manner, the police sometimes pose a threat to residents and share economic interests with drug dealers. So, for residents, the police are both a protector and a source of violence either.

2.2.3. Drug traffickers and the police

Two factors determining the relationship between the police and drug traffickers are the power and the economic interests. The police sometimes arrest drug traffickers to respond to political policies. But most of the time, they cooperate with drug traffickers to share economic interests. In return, drug suppliers also make use of the police power to suppress their internal conflicts. The two groups of police and drug traffickers are the same or similar individual behavior under different names. The reason the police can maintain a different identity from drug traffickers is that they are always more alienated from Favela.

Usually in larger social groups, the residents and drug dealers are very separated individuals, however in the area of the favela the police officers are far more alienated than drug smugglers. This level of alienation reflects the impact on urban development. In the process of favela’s formation, the influence of the residents is greater than the drug traffickers and the police.
2.3. STRUCTURING THE COMPLEXITY

Even though there is the trend self-organizing system taking over hierarchical system, it is realized only happening on some specific scales. Inside of drug trafficker group, the hierarchy is obvious and strict. It is the same with the police who is part of the authority of the state. Even in the resident group, some people are recognized with higher authority and man and women have different social status. It indicates that the hierarchy and self-organization are intertwined and even inseparable. The components of self-organizing system could be disassembled as hierarchical systems. Some mutation happens on some layers- individuals or small groups-turning the entire system to self-organizing. To make it clear, there are two aspects appear to be significant in understanding the complexity of a self-organizing system. First, it is closely connected with hierarchical system-evolved from it or formed with it at the same time. Second, mutations happening in the hierarchies is enhancing the complexity of self-organization.

In the group of drug traffickers, some people revolt against the old system with violence. When their forces are not powerful enough, they borrow from the police. The reason the alliance succeeds for the police is to weaken the power of the entire drug trafficker group or, sometimes, to get financial benefits from drug trading. Mutations breaking the old hierarchical system happen disorderly and unpredictably. It could be converted to random factors in computation.

Individuals as components are not stable- they switch their social roles unpredictably. Also the death rate and birth rate is unpredictable. These will cause difficulties for computation. But it is realized that the properties of social systems are much more stable than the individuals. When residents turned to drug traffickers, the individual’s personal identity changes completely, but the overall structure of the social groups is not affected that much. Therefore, it is more feasible to model social systems instead of individuals as components. In fact, the social systems modeled as components are subsystems of the entire system. And an individual could be the smallest subsystem.

3. Computational simulation

Ant colony algorithm was introduced in the early 1990’s. It is one of the main algorithms for agent-based modelling. The inspiring source of ant colony algorithm is the foraging behavior of real ant colonies. This behavior is exploited in artificial ant colonies for the search of approximate solutions to discrete optimization problems, to continuous optimization problems, and to important problems in telecommunications, such as routing and load balancing. This idea is simulated based on Ant Colony Optimization (ACO) rules using Processing (Java). Orders on behaviors were set for the class with some random factors. The behavior of the agents appeared to be topological. The entity shows a relatively stable pattern after some iterations.

To study the interactions with the external, new group pf agents were added but they were set different behaviors. The elastic calculation formula was applied here to illustrate tension and pressure, indicating the relationship between two individuals from different groups. When the coefficient K is bigger than 0 (K>0),
It indicates the tension between the two systems indeed. On the other hand, when \( K < 0 \), it shows the pressure. The value of \( K \) is randomly taken between -1 to 1 at the initialization part.

\[
F = KX
\]  

(1)

Considering that the relationship between the two groups of agents is not a simple linear connection, the elastic potential energy calculation formula is more appropriate:

\[
F = KX^2
\]  

(2)

Here are the corresponding arrangements of agents in different moments (Figure 1, Figure 2 and Figure 3).

Figure 1. Simulation of three interacting multi-agent systems.

Figure 2. Simulation of three interacting multi-agent systems.
The biggest challenge in this simulation is the connection between two groups. It is found difficult to link two autonomous systems. The method used here was to connect every new agent to an old agent. The new group of agents appeared to follow the bottom-up mechanism either. And it is disordered, decentralized and complex. It shows how external factors influencing the complexity of a self-organizing system as well as internal factors.

4. Conclusion

On the current stage of this research, it is just a beginning to simulate the urban. Comparing the simulation result with the real urban operations, similarities could be found. The distribution, the density and the movement of social groups could be corresponding with the real city. To a certain extent, it proved the hypothesis about subsystems and social mutations provided a perspective to understand the city. With further development on algorithm and further studies of sociology, it is possible to reproduce the city in computer. And it is possible to connect computation with the reality much more tightly. In the future, the organization of the city will involve the virtual besides of the physical. And the connection between the two is social interaction.

Several points need to be drawn from this attempt. First, self-organizing system is not replacing hierarchical system, but the two keeps a symbolic relationship. For systems appearing as self-organizing ones as an entity, there exists subsystems with hierarchies. Second, the complexity is produced from many unpredictable factors. Birth and death rate, transformation of social roles and the population base all contribute to the indeterminacy. It could be understood as mutations of biology which cause biodiversity. The mutations of social behaviors lead to the complexity of the system. Third, the component of a society is social system instead of individuals. Individual could be the smallest social system. The status of a single person is not that stable as the status of a social system. Forth, a system is not only about internal factors but also involve external factors. A
single person could be a social system as long as he has interactions with multiple external factors.

For further studies, more urban details of the favela need to be studied. The influence of social interactions on transportation, circulation, distribution of houses, the composition of population and other aspects will need to be studied. Social mutations or self-organizations of it will still be the focus. Many theorists including Benjamin Bratton have predicted that the future city would be a sum of not only physical but also virtual parts. It indicates that virtual parts need to be understood physically, meanwhile physical parts need to be understood virtually as well.

References