Multi-agent Modeling of Civil Disobedience and Violence

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***Abstract*—This project was intended to simulate the dual types of conflicts that arise in globally typical situations of conflict that arise due to disagreement over power. Rudimentary research in the field of modeling civil disobedience has occurred, but a comprehensive and thorough analysis of the spectrum of human variables that play into such conflicts has not yet been tested. This project was to implement individual agents with unique attitudes toward central authorities and opposing factions, utilizing the Multi-Agent Simulator of Neighborhoods (MASON) library, to simulate default societal and human characteristics. Rules of human behavior were based on past theoretical studies in the field, and extensions of these analyses would have occurred with further time permitted. This project, though incomplete, provides compelling reasons to encourage further study within this field.**

***Index Terms*—civil violence, centralized authority, rebellion, communal violence**

I. Introduction

1.1 Purpose

THIS project sought to use currently existing simulation software to model a variety of situations in which one group of people become antagonized with another group, whether it be a centralized authority or an opposing, but socially equal, group. By implementing past theories and research into the human psychology that influences people to act in such situations, it was hoped that an understanding of the underlying causes and nature of such conflicts would be found. The Multi-Agent Simulator of Neighborhoods (MASON) was utilized as an environment within which to create a simulated ecosystem that could harbor individual agents with unique traits that could act independently in light of an oppressing regime or opposing faction. This research is important because it helps shed light on group interaction in situations of tense conflict; these could include a coup d'état, warring tribes, or the primary test situation for this project – a jail break, involving prisoners fighting against each other and their jailors.

1.2 Scope of Study

As this project builds upon past research, it is not intended to recreate past results. Instead, it will use previously researched theories and rules that define distinct individuals, represented as agents, and their predisposed traits to simulate civil violence and disobedience. Following the implementation of basic rules of human behavior, it is expected that additional variables and traits could be tested in a sampling of the agents – however, these models would represent theoretical situations with no scientific basis; instead, they would allow for unique research permissible only with the capability of real-time testing in *simulated* agents. Therefore, while these models may provide unique and interesting results, they can not be verified to be representative of the human psyche.

It should be noted that all variables, equations, and situations within this simulation are designed to create a hypothetical world – no real-life political, economic, or social situations were imitated for the purposes of this project. Such case studies would obviously be an eventual goal to build upon the results of this study, however.

II. Background

2.1 Multi-agent modeling

Multi-agent modeling utilizes agents, considered individual components with the ability to learn from their environment and change their behavior in response, to simulate real-life situations in an increasingly complex world. Interdependencies and relationships between individuals are very difficult to reproduce using human subjects with predispositions and human tendencies that are impossible to compensate for efficiently, and thus multi-agent modeling serves as an effective means to approximate their behavior, provided sufficient background information about each unique agent.

2.2 Previous Research

This project builds upon the general theories and equations of civil disobedience and violence, as found in Epstein [1]. Epstein's work builds upon previous traction made in this field of study by offering a novel and promising approach to "understanding the complex dynamics of decentralized rebellion and interethnic civil violence."[2] While he analyzes simple tests of the cops, agents, and opposing groups, he fails to extrapolate more upon his data or use his findings to investigate hypothetical traits not considered in his initial research, a goal of this project.

2.3 Other Multi-Agent Simulations

While this project aimed to deal with civil disobedience and organized violence, other projects have used multi-agent modeling software (primarily MASON) to examine the interactions and behavior of human and more simplistic agents.

The most famous example of a simplified multi-agent

model of human behavior would be Conway's Game of Life. Conway creates simple rules for so-called human agents to consider as they reproduce and die off, a *very* simplified version of the human interactions this project aimed to deal with.

Other examples include mnemonic structure and sociality [3], cooperative target observation [4], and ant foraging [5].

III. Theory and Design

3.1 Initial Research

Preliminary forays into this field required understanding of the NetLogo, and later MASON, modeling software. As such, initial research comprised of understanding how to use and manipulate these programs, utilizing pre-existing applets such as traffic flow simulations and virus infection scenarios.

3.2 Rebellion Against Central Authority

To create a hierarchical system of authority, multiple types of agents were necessary. The two categories of actors composed of Agents and Cops, with Cops instructed to arrest Agents who appeared to be rebelling.

3.2.1 Agent Characteristics

Agents are intended to be representative of the masses within this simulation – just like in the real world, they do not assume a position of authority easily, and thus cannot "convert" into Cops. Thus, the primary variable that directs an agent's movements becomes a representation of its political grievance. In this simulation, in accordance with Epstein, grievance is represented in two variables: hardship (H) and legitimacy (L).

Hardship is designed to represent an agent's predisposed troubles – it is a value that was randomly assigned in my simulation, but can be manipulated to better represent a group of people. The value is a decimal from 0.00 to 1.00, and uniformly distributed.

Legitimacy represents the *perceived* legitimacy of the central authority. Although different people may perceive the legitimacy of any regime differently, it is expected that these represent standard deviations from the true legitimacy of the controlling body. Thus, for the purposes of this simulation, this value is uniform over the distribution of agents.

Obviously, in order to determine an agent's grievance, it is required to determine the relationship between an agent's perceived hardship and perceived legitimacy of the authority. For the purposes of this simulation, the following equation is used to represent G, an agent's grievance:

$$G = H(1 - L) \tag{1}$$

Thus, grievance is derived as the product of perceived hardship (H) and perceived *illegitimacy* (1-L). This formula, while simplistic, serves to help create an accurate simulation: if agents suffer no hardship or perceive the government as fully legitimate, the product of the variables results in a grievance of null. However, if hardship is already high and the government is revealed to be more illegitimate than previously thought, grievance levels may precipitously increase.

For agents to be realistic simulations of their human counterparts, however, there must be more consideration for agents to rebel than simply their grievance. Predisposed traits, whether through nature or nurture, must be accounted for. Accordingly, we simplify this part of an agent's personality into a single variable: R, an agent's level of risk aversion. This variable is drawn from the uniform distribution of values from 0 to 1, and allows for more personal traits to be imbued in each agent.

After each agent's individual traits have been determined, it is important to recognize the interactions that occur between different agents just as they do in the real world. One of the most important factors an agent must consider before turning "active" – public acts of grievance – is their arrest probability. Represented as P, it can be defined as:

$$P = 1 - e^{-k(C/A)_v} \tag{2}$$

Defining V as the agent's vision – the number of positions the agent can see in each direction – and K as a constant – to ensure a plausible estimate even when Cops (C) and Agents (A) within view each equal 1. Thus, $(C/A)_V$ represents the cop-to-agent ratio within view, an important factor in deciding whether the agent goes active. For example, if there 5 cops within view and no other agents around, the initial Agent is highly unlikely to choose to go active at that time. However, if those 5 cops are overseeing 1000 active agents, the initial Agent's arrest probability will not be very high and he is much more likely to go active. Thus, the agent's behavior can be predicted by defining his net risk (N):

$$N = RP \tag{3}$$

The sum of these formulas defines the agent's ultimate actions: if an agent's grievance (G) exceeds its net risk (N) by some arbitrary standard, the agent will go active. Active agents publicly rebel against the authority and remain "active" until they are jailed or no longer aggrieved.

3.2.2 Cop Characteristics

Cops, fortunately for the program, are infinitely simpler than Agents. Because cops are trained to inspect all sites within their local vision and arrest law-breaking ("active") agents, their behavior is simplistic in nature. This should not be viewed as a lack of personal traits on the part of the Cops – they are simply trained to do their job, and their job is to arrest miscreants. It is important to note that the Cops' vision, V, is uniform; however, it need not be identical to the vision of the Agents. Presumably, Cops need to be more aware of their surroundings and so they likely have a greater sense of vision.

3.3 Testing

Testing of the program was hampered by limited progress. Despite this, analysis based on current versions provided

interesting results.

When varying the number of agents and cops, the simulation depicted each acting differently. When there were a multitude of agents, they either remained passive or became active in groups. This is likely a representation of the bystander effect – people are more likely to rebel when others have begun to rebel. After an initial agent's grievance exceeded his net risk, he turned active and other agents, in accordance with a lower arrest probability, followed suit. This is a proven human reaction in real life as well, giving credence to the model's ability to imitate and predict human behavior.

Other tests included varying pre-defined levels of hardship, legitimacy, and risk aversion. By altering the predispositions of the group from a uniform distribution between 0 and 1, skewing the numbers one way or another caused the agents to act differently. If hardship or legitimacy were artificially increased, grievance levels rose exponentially; likewise, the opposite happened when they were artificially decreased to minute levels. Increasing risk aversion caused agents to stay further away from cops in the model; typically, it took longer for agents to turn active as they actively avoided cops rather than considering a small number of cops to be an acceptable risk. These tests showed that, at a very basic level, this model and its associated formulas tend to depict primal human behavior. Further study and more thorough research are necessary for more accurate imitations of behavior, however.

IV. Conclusion

4.1 Results

This simulation of human behavior, although rudimentary, has depicted a variety of situations which allow us to model civil disobedience and violence. The program, in its current incarnation, proved to accurately, if simplistically, imitate human behavior that arises in such situations. Based on the testing, it is clear that, given additional time and development, this multi-agent model could evolve into a useful tool for analyzing – and predicting – instances of generalized rebellion.

4.2 Discussion

This program has provided for an accurate model of human behavior. By utilizing a variety of human traits and factors – including hardship, legitimacy, risk aversion, arrest probability, vision, and net risk – we have been able to visualize instances of rebellion. Regretfully, additional factors such as jail terms, population densities, deceptive behavior, free assembly, relative stability, and corruption were not able to be included. Such items would have allowed for further insight and created a more comprehensive model. It is impossible to draw absolute conclusions from this model currently, but including such ideas would allow for a more believable simulation.

As it stands now, the program unfortunately only confirmed known principles in instances of civil disobedience and violence. Increasing "problems" – such as hardship and illegitimacy – incited agents to rebel quicker. When agents began to go active, others followed suit – the bystander effect in action. Future iterations of this program may instead reveal ideas and principles not obvious already.

4.3 Future Recommendations

Recommendations for future developers of this project include implementing all discussed features. Furthermore, instead of 2D representations and inferences based on such models, 3D representations and directly related graphs and tables would allow for more concrete, quantitative data to be collected. In addition, other ideas related to civil disobedience and violence – such as a central authority attempting to suppress opposing factions – should be implemented. In summation, while this program made strides in *imitating* human behavior, future versions will hopefully be able to *predict* human behavior.

V. Acknowledgment

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VI. References

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