SWEN90004 Modelling Complex Software System

Assignment 2 Report

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1 Background

The chosen model for our analysis is the **Rebellion** model. This model is based on model of civil violence by Joshua Epstein (2002). The aim of this project is to replicate this model and study how this complex system behaves in different stages and under different settings. It describes the how agents behave against central authority in relation to their grievance and the power of authority.

Rebellion is a complex system. Firstly, this model is made of many individual instances, each of them has individual state, but at the same time, their behaviour (i.e. state transitions) are affected by other states of other instances near them. Secondly, the states of the whole system is unpredictable at a certain time t with a given set of inputs. This is due to the interrelation and interactions between states of different instances and certain degree of randomness in this model. Thirdly, under most settings, the model is decentralised. The vision of most instances cannot cover the whole board. Also, all agents are the same, and all cops are the same, none of them is a leader in this model. This implies they all contribute the same amount to influence the states of the model. Fourthly, there is feedback on the behaviour of agents. Active agents can eventually influence agents around them and lead to more active agents. Also, more active agents will attract more cops to enforce on them, which leads to more quiet agents. Finally, although there exists regular patterns for states of the system, but it does not approach to an equilibrium.

2 Model

The model includes the following major components:

2.1 Board

Board is the representation of the world in this model. It is set in default to contain 1600 (40×40) patches in total.

2.1.1 Patches

Each patch in the board has two states, *empty* and *occupied*.

2.2 Agent

Agents are the representation of ordinary individuals in this model. Agents have three states, *active*, *quiet* and *jailed*. They are default to be *quiet* at the beginning. Agents will be able to move to any empty patches in their vision when *MOVEMENT* value equals to *true* every tick. They will update their state after the movement phase according to the following equation.

$$\begin{aligned} &grievance - riskAversion \times estimatedArrestProbability > threshold \\ \text{Where } &grievance = perceivedHardship \times (1 - governmentLegitimacy) \\ \text{and } &estimatedArrestProbability = 1 - e^{-k \times ((1+activeCount)/copsCount)} \end{aligned} \tag{1}$$

When this equation holds, their state will become *active*, otherwise it will be *quiet*. Both the number of active agents and number of cops around them will be factors that decide their behaviours. If active agents are in the vision of cops, there will be possibility for them to become *jailed* by the enforce action of cops. A random jail term between 0 and the maximum jail term allowed will be given to them and they are not able to move or action during that time. However, a patch contains jailed agents are still considered as *empty* when no other agents or cops on it.

2.3 Cop

Cops are the representation of power of authority in this model. Cops are always allowed to move to empty patches within their vision at every tick. They can enforce at most one active agent within their vision at each tick and move to their patches.

3 Extension

The extension we have implemented is that the government legitimacy will increase as the proportion of jailed agents to number of total agents increases. The equation we derive is

$$GovernmentLegitimacy = InitialGovernmentLegitimacy + \frac{JailedAgents}{TotalAgents} \times (1 - InitialGovernmentLegitimacy) \quad (2)$$

4 Replication

Initial cop density	0.04
Initial agent density	0.70
Vision	7
Government Legitimacy	0.82
Max jail term	30
Movement	True

Table 1: Setting No.1

5 Extension

6 Results & Discussion

7 Conclusion