

# Modelling Population Riots

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## Abstract

Using Epstein’s Agent Based Civil Violence Model To suppress Rebellion, as well as see how smoke can be used to suppress an uprising.

## Introduction

Instances of large-scale disorder occur frequently around the world, resulting in significant damage to property and, at times, human life. Given the destructive nature of such events, it is crucial to develop models that can accurately capture the dynamics of rioting and identify potential strategies for mitigating the damage. In this report, we present an agent-based model (ABM) that replicates the behaviour of riot populations, and we demonstrate how the use of smoke by police forces can effectively reduce the number of participants in a riot.

## Mathematical Model

First off every agent has a certain level of risk aversion (R), the amount an individual will avoid risk, and a level of Hardship (H). As well as vision (v) which is an area around each individual in which they scan and count the number of people around them.

The grievance (G) that someone has is given by:

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

Probability of a non police officer agent to get arrested is given by:

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

where C the number of police in v and A the number of active’s in v. k is determined by if C=A=1 then we have P=0.9 hence we have k=-ln(0.1)

With R and P now defined we can calculate the net Risk N = RP giving us our final rule

we now have all we need to create the agent rule:

*Agent rule : if  $G - N > T$  riot; otherwise stay a civilian* (3)

so the difference in G and N is the expected utility of expressing ones private grievance whilst T is the utility of not.

## Reduction in Police Forces

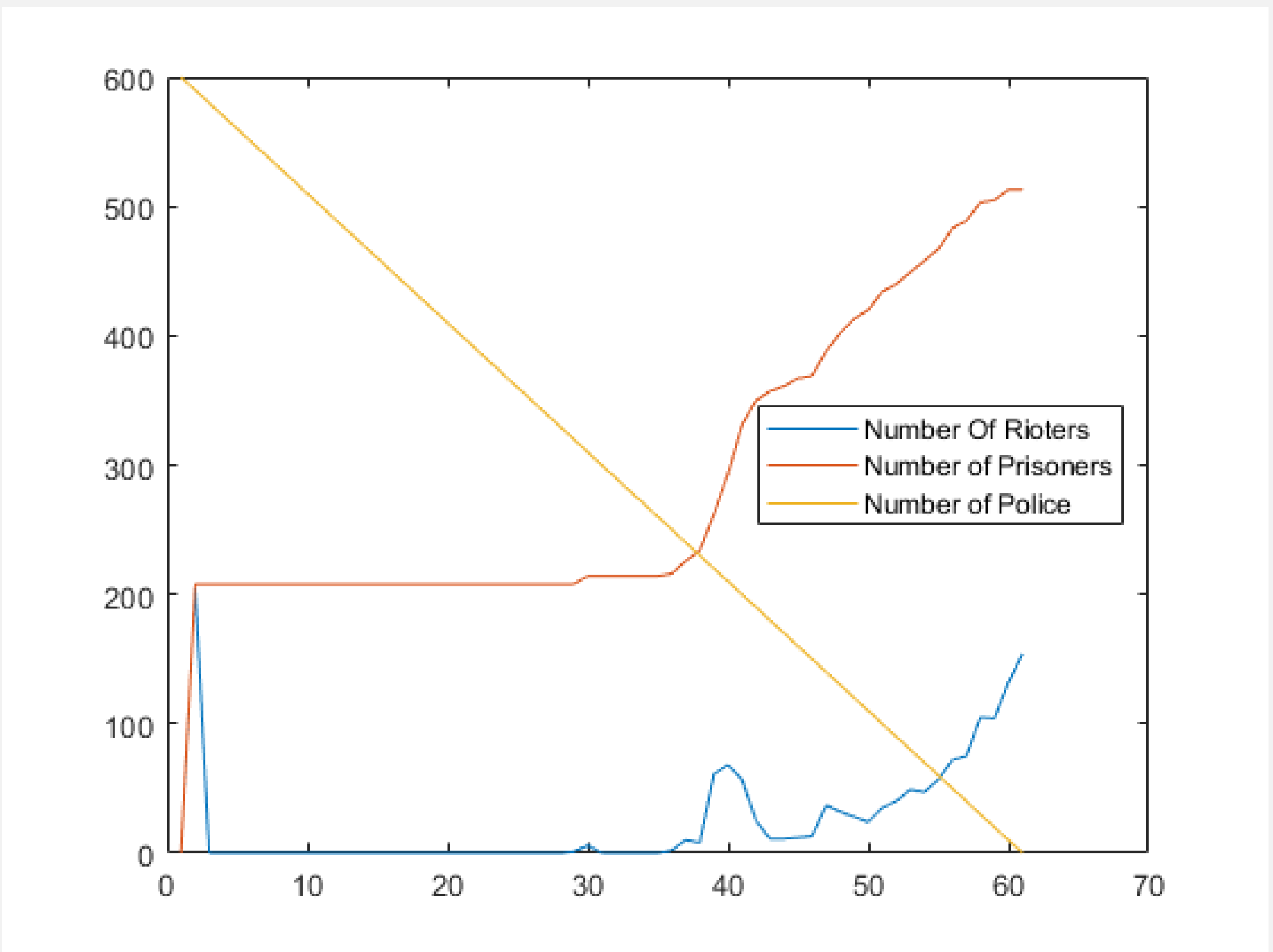


Figure 1:C=600,Q=800,v=2,L=0.4,T=0.1

## Conclusions

- A sudden drop in Perceived Legitimacy of a government can cause an uprising
- Obscuring vision can help prevent large scale disorder
- Outrage towards a government has a "snowball" like affect

## References

1. Epstein, Joshua M. Modeling civil violence: An agent-based computational approach. 2002
2. Bonnasse-Gahot, Laurent and Berestycki, Henri and Depuiset, Marie-Aude and Gordon, Mirta B and Roché, Se-

## Computational Model

### -Agent Movement

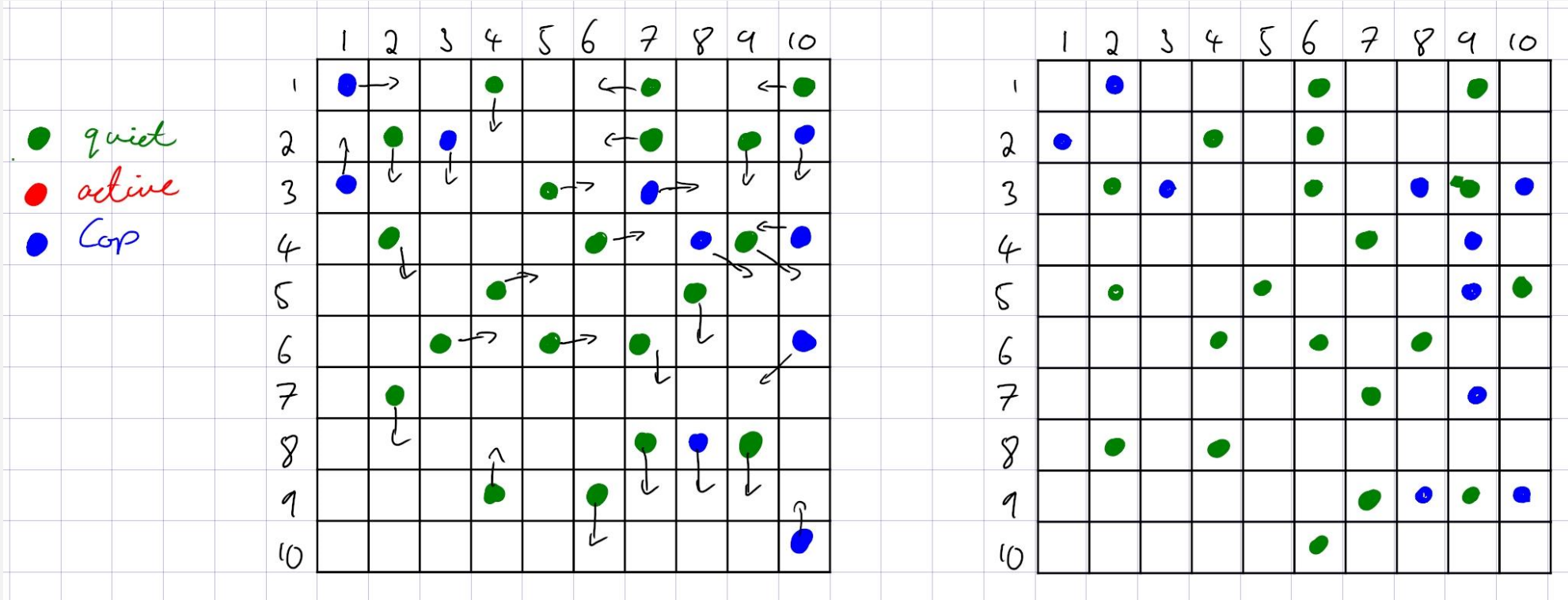


Figure 2:Agent Movement

### -Vision

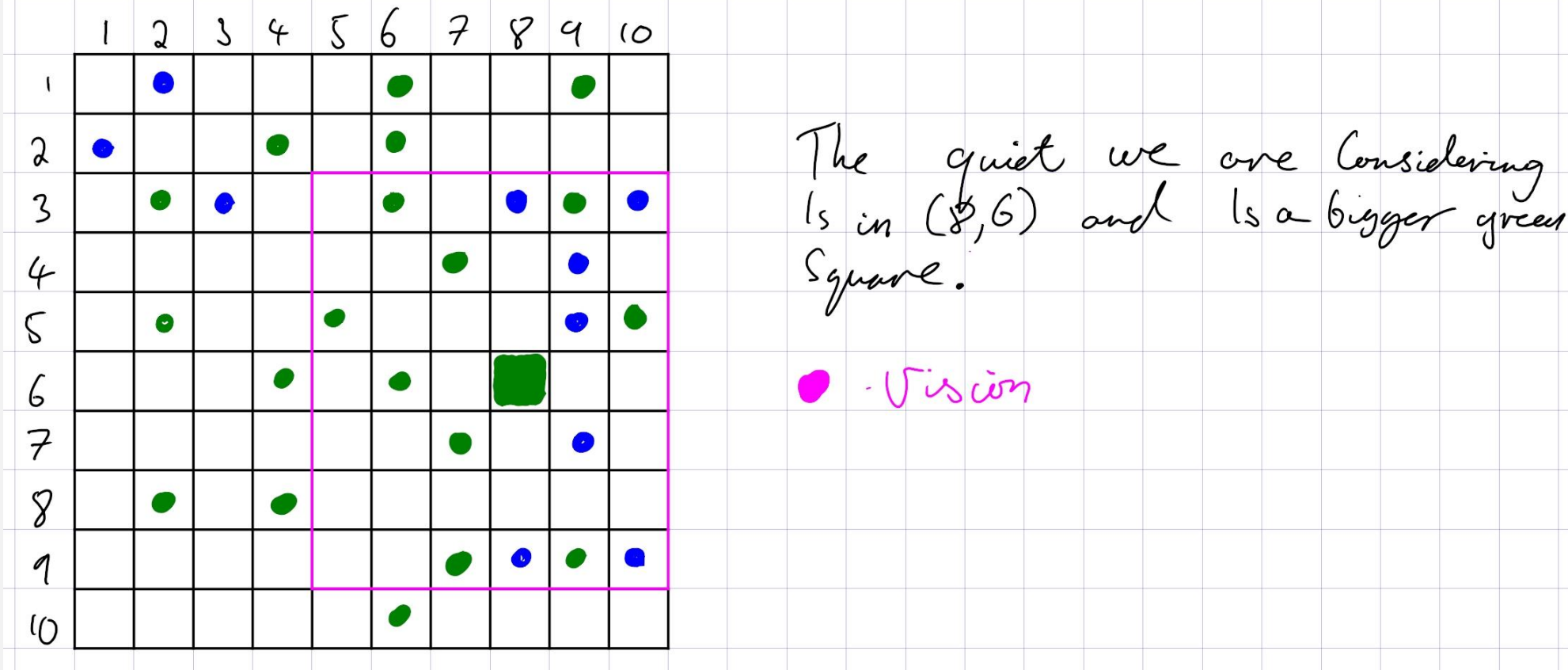


Figure 3:Vision

### -Arresting

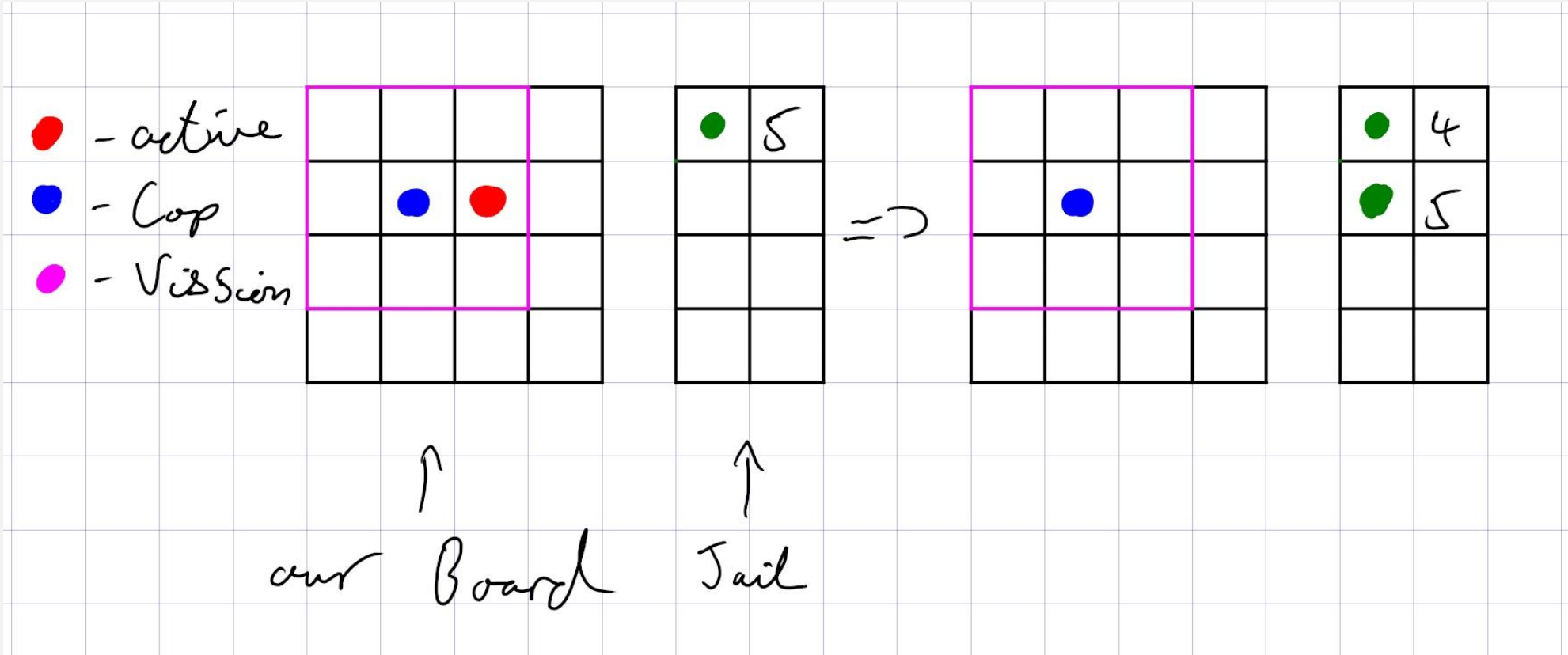


Figure 4:Arresting

### -Smoke

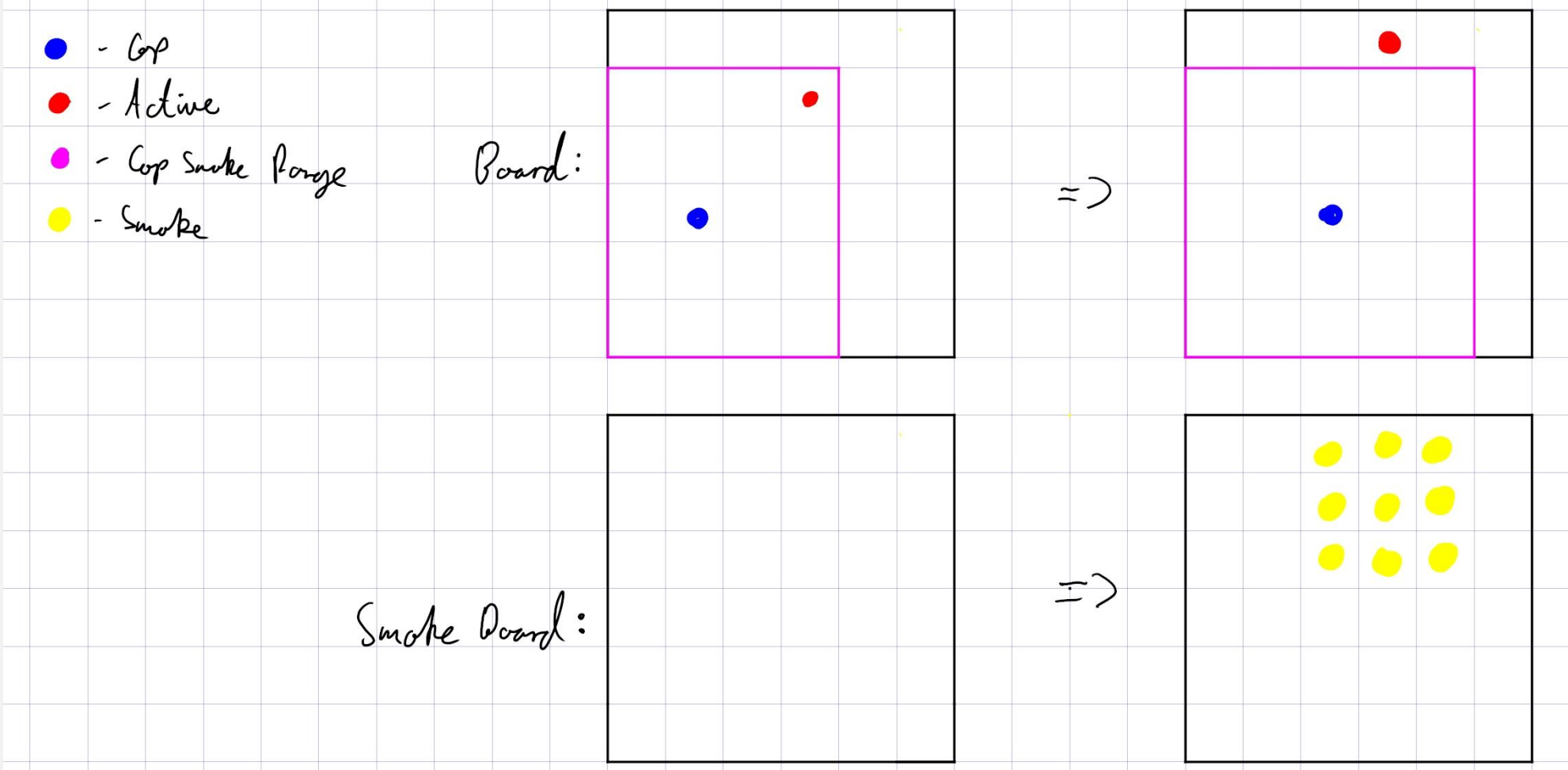


Figure 5:Police Smoke

## Agent Behaviour

### -Deceptive Behaviour

### -Snowball Effect

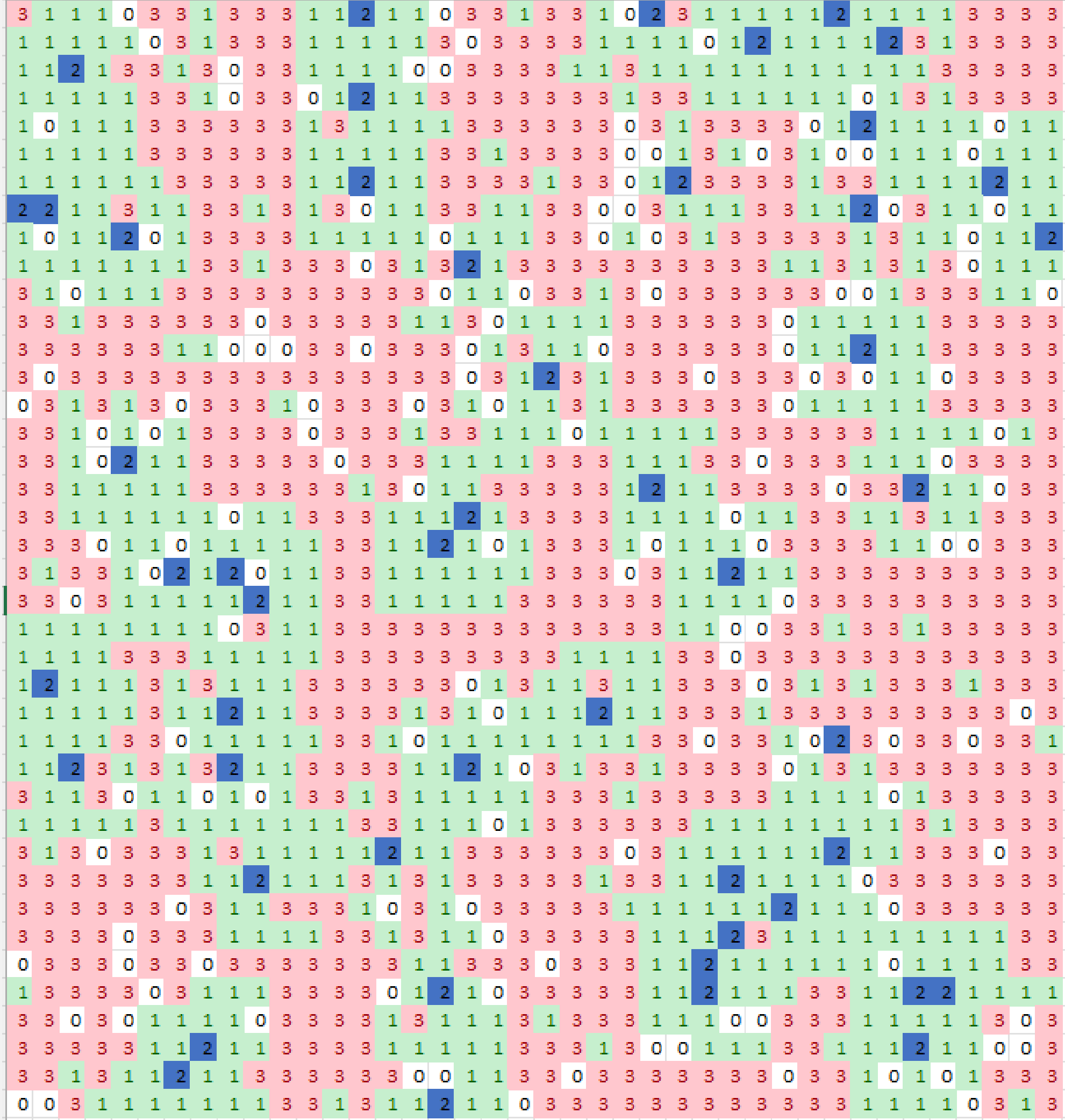


Figure 6:C=1400,Q=50,V=2,T = 0.01, L=0.89

## Effect of legitimacy

### Slow Decline of Legitimacy

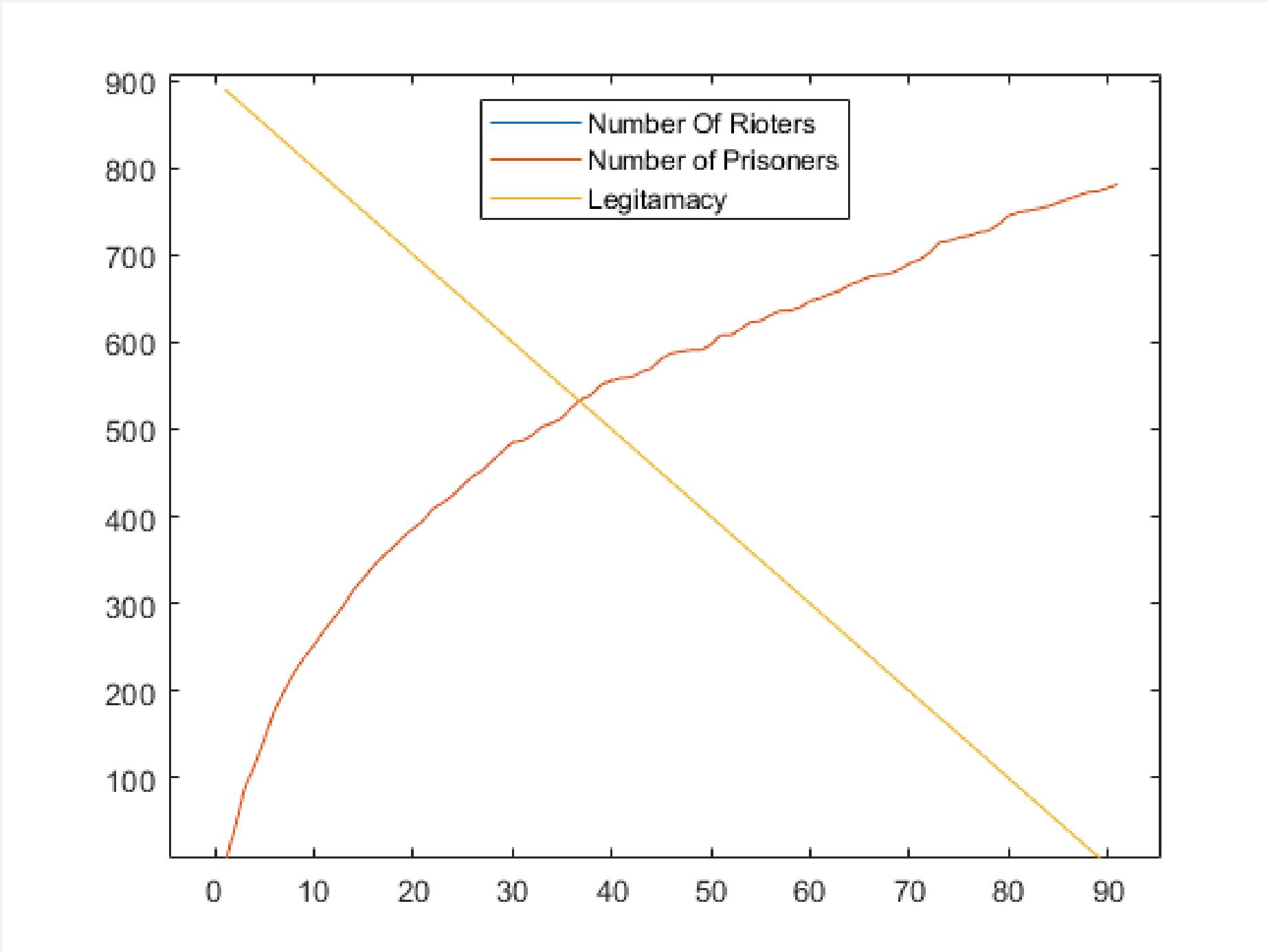


Figure 7:C=50,Q=1400,v=2,T=0.1,L=0.9-0

### Sudden Drop In Legitimacy

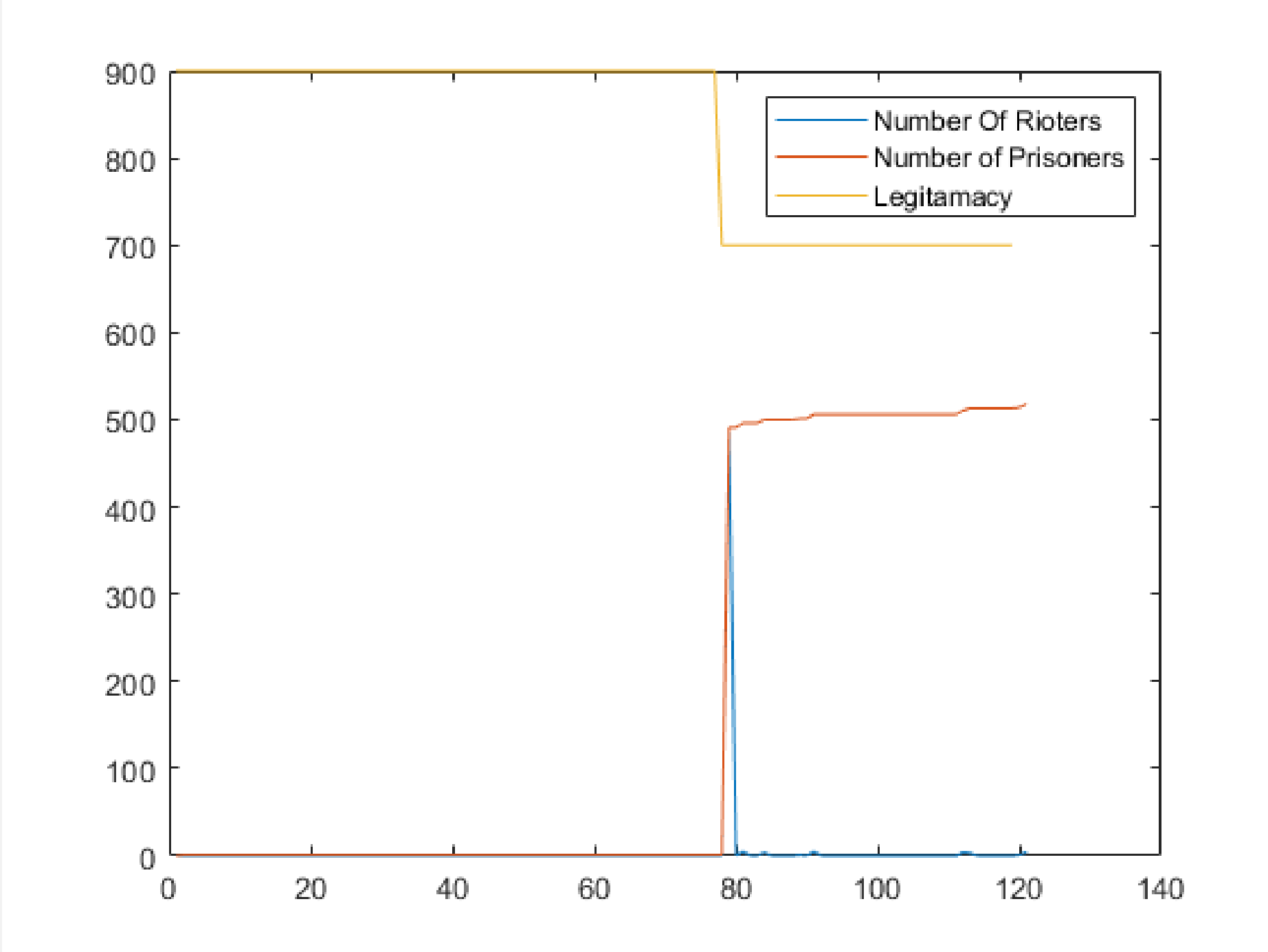


Figure 8:C=50,Q=1400,v=2,T=0.1,L=0.9,0.7

## periodic Outbursts Of Violence

### -Periodic Outbursts of Violence

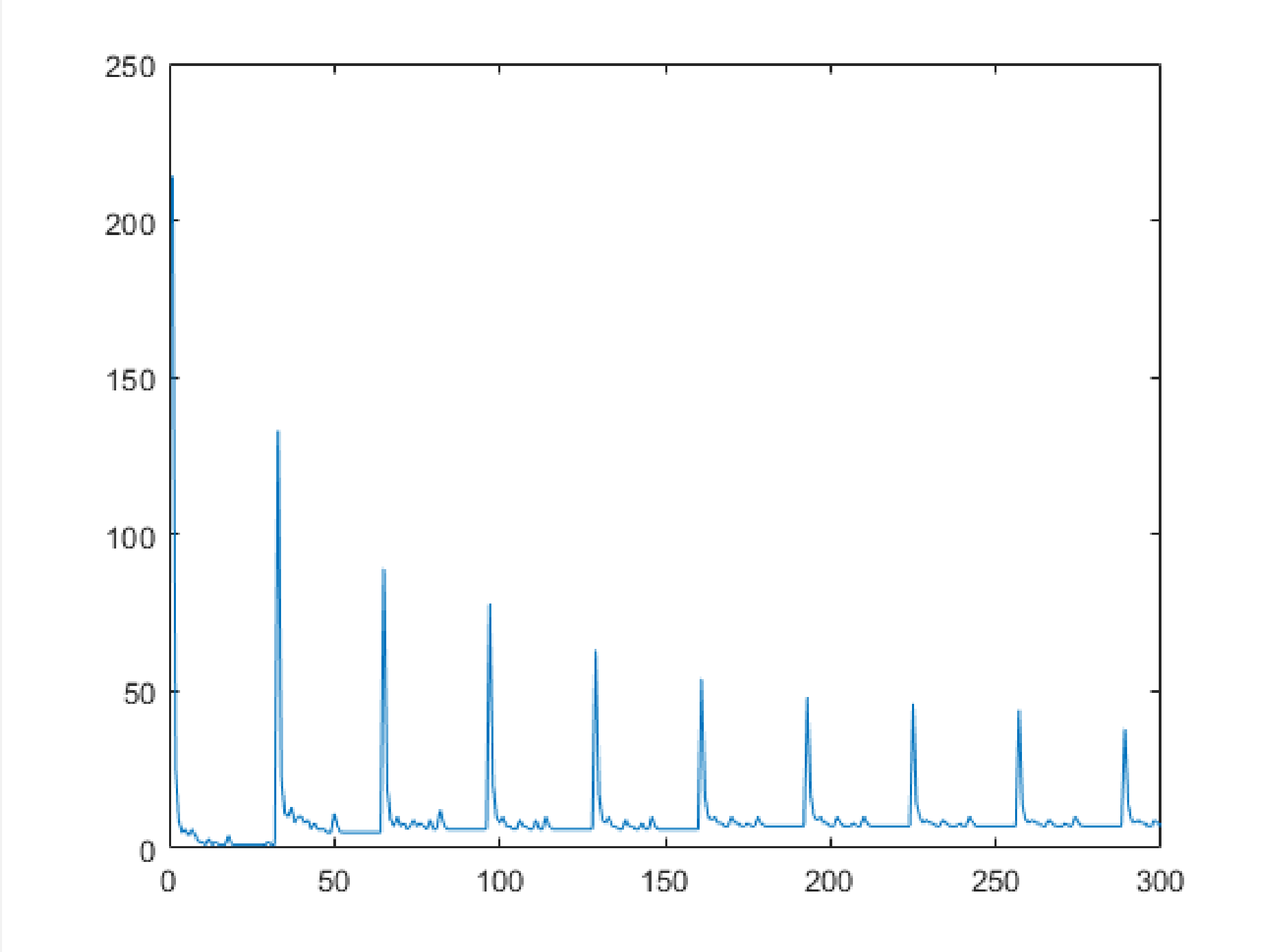


Figure 9:C=50,Q=1400,v=2,T=0.1,L=0.89

### -Smoke Used To Reduce Number Of Actives

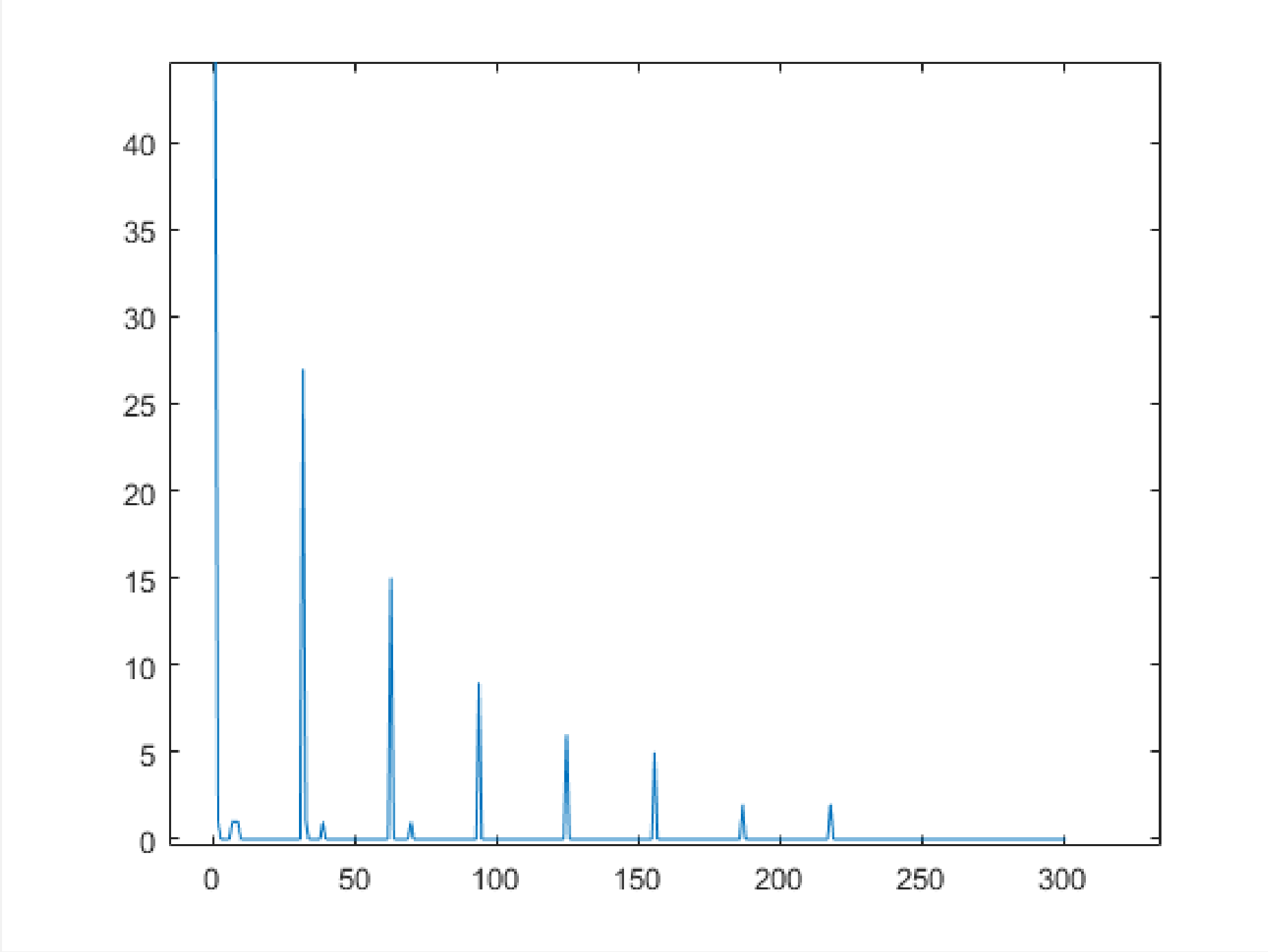


Figure 10:C=50,Q=1400,v=2,T=0.1,L=0.89