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Agent-Based Modeling of Social Conflict

From Mechanisms to Complex Behavior

Springer

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Carlos M. Lemos
Department of Religion, Philosophy
and History
University of Agder
Kristiansand, Norway

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To my wife São and my daughters
Mariana and Marta

Preface

Simulation of social conflict phenomena using agent-based models and the methods of complex system studies is a topic of growing interest, for it provides a degree of insight and understanding not attainable using classical methods of disciplines like anthropology, sociology, social psychology, and political science.

This book describes a study of large-scale conflict against a central authority using an extension of Epstein's agent-based model of civil violence, which started with and builds on my PhD dissertation. The key idea was to extend Epstein's classical model by including mechanisms such as dependence of grievance on relative deprivation, legitimacy feedback, and network influence effects, using simple formulations inspired on social conflict theories.

The scope of the work is the description of large-scale and low-intensity conflict phenomena that involve a significant proportion of the population and are (mostly) self-organized. The purpose of the study was to show how the newly introduced mechanisms increase the generative capacity of the original model and to discuss the plausibility of the patterns of magnitude, duration, and interval of the simulated conflict events, by comparing them with corresponding statistical descriptions of conflict events in some countries affected by the "Arab Spring." As in Epstein's model, the dynamics of conflict are described by the interaction between two populations of artificial agents: "citizens" which remain quiet or rebel and law-enforcing agents (or "cops") which arrest rebellious "citizens." Armed conflict and other conflict manifestations that involve higher violence intensity and organized structures (e.g. insurgences) are not considered. Religious and ethnic conflicts, which would require agents endowed with identity and consideration of more complicated micro-interactions, are also not studied.

The book is organized as follows. The first three chapters contain the introduction (Chap. 1), a summary review of social conflict theories and related concepts (Chap. 2), and a discussion of Epstein's model with emphasis on key variables and mechanisms (Chap. 3). Chapter 4 contains a statistical description of conflict events based on the Social Conflict Analysis Database and an analysis of indicators related to legitimacy, human rights, and inequality, for eight African countries affected by

the "Arab Spring." This chapter addresses aspects of general interest, such as the usefulness and limitations of the information in databases of conflict events; the limited value of indices of legitimacy, human rights, and inequality as prognostic tools; and above all the complexity of real conflict processes. These analyses provide useful information for discussing the plausibility of computer simulations and illustrate the issues and limitations inherent to the parameterization and validation of agent-based models of social conflict. Chapter 5 contains a description of the agent-based model developed in this work, with emphasis on the extensions to Epstein's original model: vanishing of the risk perception below a critical ratio (set via an input parameter) between deterrence and "group support," deprivation-dependent hardship with variable sensitivity to deprivation (to represent the difference between political and economic deprivation), endogenous legitimacy feedback, and network influence effects modeled via dispositional contagion. Chapter 6 describes a set of simulation experiments that illustrate the generative capacity of the model and the influence of the newly introduced mechanisms on the complexity of the solutions. The results in this chapter highlight interesting aspects, such as how patterns of magnitude, duration, and recurrence of simulated events are influenced by input parameters, the occurrence of solutions with different regimes (calm, intermittent peaks of turmoil and permanent rebellion) in scenarios of low legitimacy and high repression, and the importance of deterrence vis-à-vis sensitivity to deprivation.

The present work will be of general interest to researchers working in social simulation using agent-based models. It will be of particular interest to those working on social conflict, under the perspectives of modeling (abstraction), the development and testing of theories, the use of indicators and databases, and the interplay between theory, models, and data analyses. Prospects for future work include improved modeling of network influences and extension of the model to religious and ethnic conflicts.

Kristiansand, Norway Carlos M. Lemos
July 2017

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I also want to thank Professor Bruce Gilley of Portland State University, for sharing his data on legitimacy and presenting valuable explanations and suggestions for modeling legitimacy feedback.

In July 15th, 2016, I started working as a postdoctoral researcher in the Modeling Religion in Norway (MODRN) project, in the Department of Religion, Philosophy and History at the University of Agder, Kristiansand, Norway. This position provided excellent conditions and the computer resources I needed for exploring the model.

Therefore, I am grateful to the Research Council of Norway, grant number 250449, for funding my contract, and to all the staff of the Department of Religion, Philosophy and History at the University at Agder, for the collaboration and support I received since I started working in MODRN. In particular, I want to thank Professor F. LeRon Shults for his interest in my work, personal support, enthusiasm, and encouragement. I also thank Senior Engineer Sigurd Kristian Brinch of the Department of Information and Communication Technology at the University of Agder, for providing me access to computer resources that were vital for performing the simulation experiments and for his help on working via remote access.

I must also acknowledge the excellent support I received from Springer during the preparation of this manuscript for publication. I am grateful to editors Christian Caron and Christopher Coughlin for their interest in my work and personal support

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Contents

List of Symbols and Acronyms

α	Shape parameter in the Pareto distribution
α_i	Learning constant for the i-th agent in Rescorla-Wagner conditioning model (salience of conditioned stimulus)
β_i	Learning constant for the i-th agent in Rescorla-Wagner conditioning model (salience of unconditioned stimulus)
δ	Exponent in generalized Rescorla-Wagner conditioning model
$\mathcal{N}(\mu, \sigma^2)$	Normal distribution with mean value μ and variance σ^2
$\mathcal{U}(a, b)$	Continuous uniform distribution with support $[a, b]$
$\mathscr{A}$	Generic agent
$\mathscr{P}$	Agent's percept
$\mathscr{R}$	Set of possible finite runs
$\mathscr{S}$	Sum of social influences in the action rule for a "citizen" agent in the ABM of social conflict
$\mu(X)$	Mean (or expected) value of random variable X
ρ	C/A, the ratio between the number of "cops" and the number of "active" citizens in the ABM of social conflict
ρ_c	Critical "cop"-to-"active" ratio below which risk perception vanishes; a parameter in the proposed form of the estimated arrest probability function (P_a)
ρ_f	Fixed point value of the "cop"-to-"active" ratio in the analytical model described in Sect. 6.1
ρ_v	$= (C_v/A_v)$
$\texttt{AG}_i$	The set of "active" citizens in the `group` network, in the i^{th} "citizen" in the ABM of social conflict
$\texttt{AINFL}_i$	The set of "active" citizens in the `infl` network, in the i^{th} "citizen" in the ABM of social conflict
var(X)	Variance of random variable X
$A(t)$	Total number of "active" citizens at time step t
A_v	Number of "active" citizens within a citizen's vision radius in the ABM of social conflict
Ac	Set of actions available to an agent $\mathscr{A}$