Project Description

Simulating the Evolution of Political-Religious Extremism: Implications for International Policy Decisions

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Cross-cultural studies suggest that major developments in human thought in every period have followed shifts in rates of information flows and levels of cultural contact [1-4, 7, 9-11]. Nonlinear models link these changes to innovations in communication technologies and global population movements [1-4]. As rates of information flows increase, those models lead us to expect opposing results on short and long time scales. In respect to political-religious movements, sudden rises in information flows are often coupled with sharp spikes in political-religious extremism, upsetting intuitive predictions of the opposite result. The best-known example lies in the massive rise in terrorism that has followed recent expansions in international travel and Internet and cell phone use, reversing early predictions that these innovations would rapidly promote cultural globalization. Similar predictions of political-cultural globalism that accompanied the first reliable world travel and rapid communications in the nineteenth century were likewise reversed when those innovations helped generate nationalistic and then fascist movements of unprecedented violence. Levels of political-religious violence similarly peaked in the first two centuries of the European printing revolution, upsetting initial promises of increased toleration that were not realized until the Enlightenment [1]. The deep lesson is that new modes of communication are as politically destabilizing in the short run as they can be beneficial agents of scientific and social change over longer periods.

This project expands on earlier models we have designed to study nonlinear developments of this sort in premodern traditions [1-4] and simulations by two of us involving the evolution of language [5-8] and studies of network algorithms [12-13]. Our current project aims to provide policy analysts and historians with flexible simulation tools to explore how shifting information flows affect political-religious movements in general. The focus of our initial simulations is to investigate ways in which the growth of modern extremist movements can be attenuated by intelligently monitoring and regulating those flows. Minor changes in the simulation architecture allow modeling of other socio-cultural phenomena for which rates of information flows serve as major tuning parameters. Configuration of simulations is achieved through an intuitive graphic user interface (GUI) that allows users to manipulate cultural variables relevant to the evolution of political-religious movements in any historical period. The simulations picture evolving social networks inhabited by intelligent

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agents whose internal properties include representations of simple beliefs and the ability to perform political acts, including those of a violent nature. Depending on the simulation needs, interactions of agents may occur in simple scale-free networks or overlapping networks with more complex hierarchical architectures [14, 15]. Other variables that can be modeled in the simulations include linguistic and economic conditions that may affect belief or action states, memberships in political-religious groups, and differing levels of connectivity in local and global networks of different types. The number and geographic location of agents can be altered to simulate changing demographic variables over time. As agents migrate geographically through the simulations or establish short- and long-distance network connections, belief and action states change in response to messages exchanged with similar or dissimilar agents elsewhere in the system. Monte Carlo methods are used to calculate the probability that passively held beliefs will give rise to extremist acts as conditions change.

Our initial simulations will test the hypothesis that the paradoxical rise in political-religious extremism that often follows the introduction of new communication technologies can be modeled as the result of the fast aggregation or clustering of previously isolated agents sharing simple and relatively fixed beliefs that is fostered by those technologies. Evidence supporting this thesis is suggested in our research on the global expansion in the last decade of extreme Hindu nationalist ('Hindutva') movements [9-11], which provide useful models for study of the growth of other extremist groups. Conversely, we hypothesize that the gradual movement towards more global and less parochial ideologies that may emerge over long periods follows from slower negotiated changes in ideas that occur when individuals holding more complex sets of beliefs remain in long-term contact. The time it takes for negotiated changes of this type to take place in evolving social networks is difficult to predict due to the nonlinear ways that information flows affect traditions in general. One aim of our simulations is to provide researchers with customizable tools to explore as many socio-political variables as possible that may accelerate changes of this type. Our initial Monte Carlo simulations will explore these theoretical issues using 'toy' data to investigate the conditions that amplify or attenuate political-religious extremism in different historical scenarios. Second-generation simulations are planned that will extend the same methods to analyzing data from real-world extremist groups, using input from Internet and other quasi-real-time information sources.

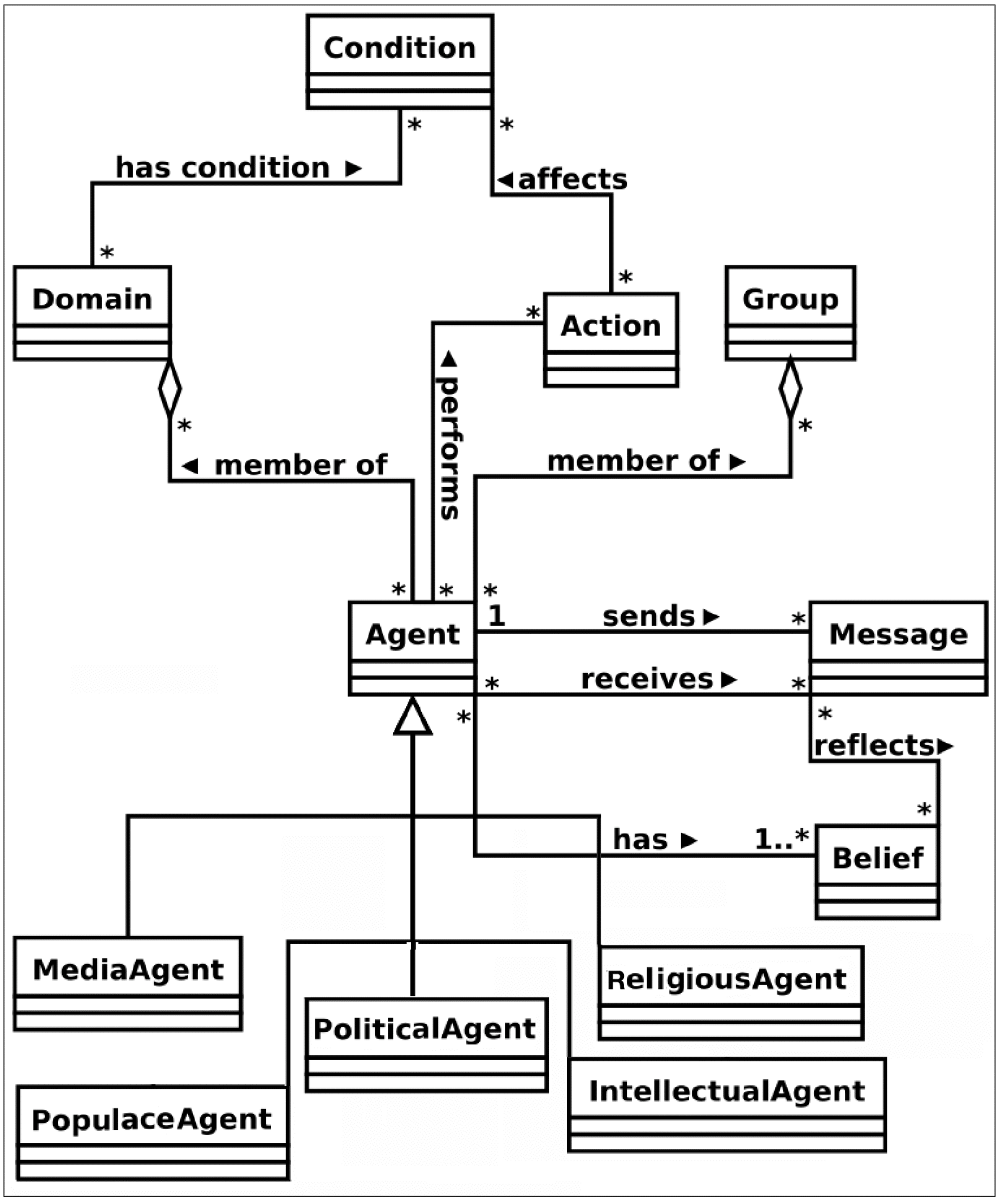
One idea we plan to test in our early simulations is the hypothesis that attempts to isolate members of potential extremist groups, implementing a frequent real-world policy decision, may paradoxically help sustain violent tendencies by limiting opportunities for the negotiated changes known on long time-scales to weaken such tendencies.

Detailed overview of the simulation design

Our simulation design revolves around an agent-based model of evolving social networks. Differences in the numbers of agents and their interactions are expressed in the model in the evolution of group beliefs and actions. Agents of various sorts are supported by classes that deliver messages and represent internal states of belief and propensities to act. Input into the simulations uses XML formats generated via the GUI or other tools. Our initial plans call for construction of the GUI using JavaFX Script, to the extent that this novel scripting tool can simplify software development and encourage open-source extensions of our simulations.

Below is a unified modeling language (UML) diagram of the basic components of our initial simulations. The diagram is followed by a verbal description of each of those components. The initial design is centered around seven major classes. More classes can be added in the future to increase the sophistication of the simulations.

UML Diagram of Basic Simulation Components



1. **Agent Class**. Agents model individuals or, to enhance simulation efficiency, aggregates of individuals. Properties represented in agents include sets of beliefs and action states that change in response to messages exchanged with other agents using various technologies (face-to-face communications, Internet, cell phones, etc.). The evolution of belief and action states depends in part on internal rules represented in the

agents, on evolving social and economic conditions, and on agent memberships in ideological groups. Our initial simulations include five agent classes, to which others can again be added as required for specific simulations:

1.1 **PoliticalAgent Class.** Instances of this class are well connected and relatively fast acting. Members of the PoliticalAgent class attempt to push beliefs of groups in specific directions, in part using media influences and in part by initiating historical actions that alter socio-economic and network conditions. Simulations may include multiple political agents with conflicting ideologies and different levels of media influence and network connectivity.

1.2. **ReligiousAgent Class**. Important overlaps may exist between this class and that of the PoliticalAgent class, but levels of connectivity tend to be sparser and reaction times slower. Members of this class again try to push beliefs of groups in fixed ideological directions. Movements towards negotiated changes in beliefs tend to take place slowly if at all in this agent class. Simulations may again include multiple religious agents with conflicting messages.

1.3 **IntellectualAgent Class**. Instances of this agent class are richly connected and relatively slow to act. They tend to monitor messages from all groups and are equipped with elaborate rules to resolve complex intellectual conflicts. Initial belief states in this class may be highly diverse, but over the long range they move steadily towards common 'global' values.

1.4 **MediaAgent Class**. Instances of this class are fast acting and well connected. The function of the class is to filter information that reaches or emanates from other agent groups. Media agents filter beliefs passed down from political, religious, or intellectual agents, simplify those beliefs, and decide which ones should be sent on to mass audiences. Biases in media agents are determined by agent rules that depend on the types and scale of the media being represented, media ownership, and similar variables.

1.5 **PopulaceAgent Class**. Instances of this agent class tend to be sparsely connected and fast acting. They represent the largest number of agents in almost all simulations. Their beliefs tend to passively track those of the larger groups to which they belong, and they have difficulty on their own resolving intellectual conflicts. As many subclasses of these agents can be created as needed to represent competing nationalist groups or religious sects, etc.

2. **Group Class**. This class represents social collections of agents, including those in religious movements, political or academic organizations, or terrorist cells, etc. Memberships in groups help determine the kinds of connectivity that exist between agents and the frequency with which agents exchange messages. Agents may belong to a number of groups simultaneously.

3. **Domain Class**. This class represents long-term constraints on agents to interact with other agents. Domain class instances include language groups, geographic locations (which may change over time), email-list memberships, etc. Domain-class memberships generally lead to binary decisions (accept/reject) in response to messages from other agents.

4. **Condition Class**. This class represents external factors that affect the behavior of agents, including wealth or poverty or other social or ecological conditions that make agents more or less willing to accept changes in belief or action states. Major historical events that affect beliefs or an agent's willingness to act may also be represented by this class. Changing social conditions involving this class are often mirrored in the Domain class (e.g., changes in social status often mirror changes in language usage).

5. **Belief Class**. This class represents ideologies held by agents, which can both affect and be affected by messages sent to and from those agents. Instances of the Belief class may be primitives or may have children — i.e., subordinate beliefs with weights attached to them. Weights normally range from 1 (fully accept a belief) to –1 (fully reject a belief), with 0 indicating no opinion. Conflicts in beliefs may exist in agents, with internal rules (leading to rejections of beliefs or their harmonization over differing time scales, etc.) of the same type we have developed in earlier simulations involving premodern traditions [2, 3].

6. **Message Class**. This class represents the information that agents exchange with other agents, which in turn affects belief and action states. Messages in this class are handled in ways similar to those in the Belief class, with each message representing a set of beliefs normally weighted from 1 to –1.

7. **Action Class**. This class represents all actions that an agent or aggregation of similar agents might perform, depending in part on the strength of his or her/their beliefs. Actions may have nonlinear thresholds associated with them. For example, a critical number of agents must be willing to perform them before any action (e.g. a major terrorist act) takes place.

In addition to the classes represented in the UML diagram, our initial simulations contain a number of other modules called on by the simulation. These include:

1. **The Parser**, which reads input from the user setting up a given simulation.

2. **The Initializer**, which sets up the simulation.

3. **The Scheduler**, which schedules events, determines when beliefs need to be updated according to the rules used to evaluate messages, and performs similar tasks.

4. **The Statistics Monitor**, which tracks the simulation's progress and records data involving its behavior. These data are eventually shown in graphic displays.

5. **The Group Manager**, which determines when the beliefs of two groups are compatible or incompatible or when new groups need to be formed or dissolved.

6. **Graphic Displays**, which are controlled by a separate program. This program may run concurrently with the simulator, interact with it over a network connection, or may analyze simulation output after the simulation is complete. Displays of simulation results are designed to be as intuitive as possible. Our initial designs call for some of these to be displayed in geographic representations of local and global networks.

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