

SCIPR: A Computational Model to Simulate Cultural Identities for Predicting Reactions to Events

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Abstract

Today's military missions are not against other nation-states. Rather, they are against irregular forces engaged in terrorist or insurgent activities. A large part of waging successful counter-insurgency campaigns involves reducing or eliminating local support for the insurgents by convincing people that it is in not in their interest to support or join an insurgency. The Simulation of Cultural Identities for Prediction of Reactions (SCIPR) tool is designed to help military planners answer the question: "How will a particular course of action (COA) or sequence of events affect the attitudes or actions of a particular population?" At the core of SCIPR is an agent based model where agents, in response to events, change their affiliations and their attitudes based on the principles of social identity theory (Tajfel, 1978) and Social Influence Theory (Tajfel & Turner, 1979).

Introduction

The literature is consistent in stating, that the most effective strategy in waging a successful counter-insurgency campaign involves reducing or eliminating local support for the insurgents (e.g., Oberschall, 2004; Khan, 1987; Black, 2004). In other words, one must change the cultural attitudes of those not actively involved in the insurgency from acceptance of the terrorist activity to an attitude of disfavor. To that end, the United States Marine Corps (2006) has stated "the center of gravity for counterinsurgency operations is the good will of the people."

However, determining the behavioral and psychological effects of a particular action is difficult enough when done in a country with a familiar culture. It becomes even more difficult when the action is undertaken in an unfamiliar multi-cultural environment. Part of the reason for this difficulty is the fact that people maintain complex and overlapping social identities which become more or less salient in different social contexts. As such, it is not a simple stimulus-response prediction. Instead one must understand intricate relationships among

many variables to accurately force changes in attitude among a population.

For example, the following are types of identities that may make up an individual: race/ethnicity, region, gender, religion, political party, socio-economic status, etc. Each of these identities has a reaction to the events that occur and this changes their attitude to people, groups, and organizations. Further people's attitudes change based on their contact with other individuals. When people's attitudes change, then their participation in groups changes as well. As such, one can view people's reactions to events as the result of several feedback loops that interact with each other.

SCIPR is a model of these complex feedback loops based in both multi agent and systems dynamics modeling. More specifically, the computational social science basis of this research draws from the extensive literature on multi agent modeling of artificial societies and the use of these models to simulate identity and social influence dynamics in particular (Cederman, 2002; Lustick, 2000, 2001; Mackie, 2003).

The theoretical basis for the development of the model and its parameters are in the research of social identity theory (Tajfel, 1978; Tajfel & Turner, 1979) and social influence theory (Friedkin, 1998). Many other scholars have continued to develop and test the hypotheses of social identity theory, notably Abrams and Hogg (2004). Currently, social identity theory is one of the most well-developed and well-tested theories of cultural change within the social sciences. In the rest of the paper we will describe the theory and application within the model.

Social Science Theoretical Basis for SCIPR

Social identity theory is concerned most with the perception of identity and the actions that arise from this perception. Thus the most important variables related to social identity theory (Tajfel & Turner; 1979) are *identity* and *opinion*. In social identity

theory, people may have multiple identities to which they subscribe at any one time. In other words, almost all people identify themselves as members of several groups and membership in these groups (i.e., identities) determines an individual's opinions, perceptions, and actions to an extent.

Cameron (2004) suggests three dimensions of identity: *cognitive centrality*, *ingroup affect*, and *ingroup ties*. Cognitive centrality is the amount of time a person thinks about being a member of a group. This variable represents the enduring psychological salience of group identification. Ingroup affect represents the degree to which a person feels good when s/he thinks about a group s/he is in. This variable represents the value a person places on a group identity. Ingroup ties are a measure of how much a person feels s/he shares a group's fate. The second concept of importance in social identity theory is opinion. The most popular method of studying opinions as described in Social Influence Theory are models of continuous opinion dynamics (Deffuant, 2006; Deffuant et al, 2002; Hegselmann & Krause, 2002; Salzarulo, 2006).

The basis of continuous opinion dynamics in general and bounded confidence in particular are the variables *receiver opinion*, *receiver uncertainty*, *sender opinion*, and *sender uncertainty* (Salzarulo, 2006; Deffuant, 2006; Deffuant, Amblard, Weisbuch, & Faure, 2002; Hegselmann & Krause, 2002). Opinion is the name of the judgment about something in the world. Certainty is the strength with which the opinion is held.

Now that we have defined the core variables of the theories of Social identity and social influence we can turn our attention to how these variables interact to cause identity and opinion change. The theories suggest three main reasons that people change their identities and opinions: improvement of *self esteem*, increase of *certainty* (decrease of uncertainty) about the world, and *conformity* to social pressure. The self esteem motivation theory (Tajfel & Turner, 1979) says that a person can improve his/her self esteem by identifying with a group and thinking about how his/her group is good in some way (better than other groups, improving over time, better than some benchmark, etc...). A person can improve his/her certainty about the world by identifying with groups and taking on the group's opinions (Hogg & Grieve, 1999; Abrams & Hogg, 2004; Hogg, Sherman, Dierselhuis, Maitner, & Moffit, 2006) and by communicating with other people to find out their opinions (Festinger, 1954). A person can also be motivated by the desire to belong, the fear of physical punishment, and the fear of social stigma to change identities and attitudes to conform to the opinions of other people (Asch, 1955; Milgram 1974). In the next

section we describe how these theories are applied in SCIPR to predict reactions to events.

Modeling Approach

The SCIPR model design draws upon the key benefits of two modeling approaches: system dynamics (differential equation modeling) and agent based modeling. System dynamics has demonstrated in numerous studies how aggregate representations of complex social behaviors are governed by the underlying causal relationships between material and informational states and their corresponding flows. Some example studies include: the cyclic behavior in industrial dynamics (Forrester, 1961), the life and death of cities (Forrester, 1969), the ongoing problems preventing sustainable development (Saeed, 1998), and the dynamics of state stability in third world countries (Choucri, et al., 2006). One of the key benefits of the system dynamics approach is that defining the causal relationships within a system allows decision makers to identify the numerous feedback loops that either reinforce or balance certain behaviors within the system. Understanding the role of each loop then facilitates a more detailed exploration of the assumptions made in the model in comparison to what is observed in the real world.

Yet in systems where geospatial attributes and heterogeneity are critical to defining the social behavior being studied, using the system dynamics modeling formalism rapidly becomes structurally prohibitive. While certain elements can be subscripted into arrays, systems of even moderate complexity are inefficiently represented when compared to the object based approach of agent based modeling. A growing body of literature on multi-agent modeling of artificial societies has demonstrated that a variety of complex behaviors can be simulated as an emergent property of agent interactions.

Figure 1 provides an overview of the interactions that take place as well as a summary of the causal relationships that emerge from thousands of individual exchanges. The causal links shown also describe how the different social theories discussed in the next sections are integrated within the model.

Of particular interest are the causal relationships that close to form feedback loops. Feedback loops create effects that either reinforce (red) or balance out (blue) a particular behavior in each agent. Depending on the current strength of any particular loop, a wide range of behaviors can be exhibited by agents and groups of agents. Examining each of these loops in isolation helps to explain a particular driver in the overall outcome.

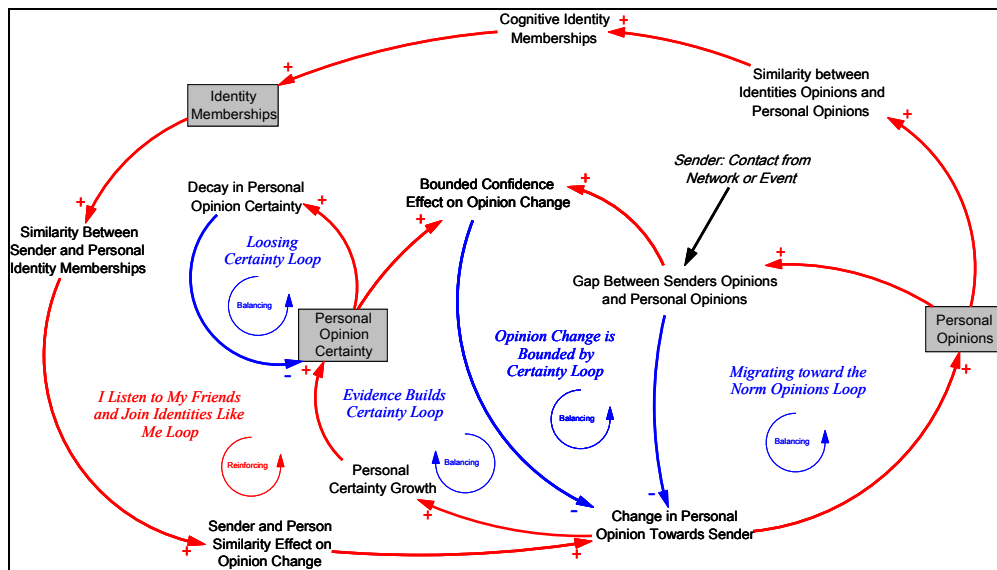


Figure 1. Overview of interactions within SCIPR.

Starting with *Identity Memberships*, each agent maintains a cognitive identity to all possible identities. These cognitive identities are derived from comparisons between the agent's current opinions and the norms of a particular identity. An agent's opinions change over time and the amount of change is determined partly by the identity similarity between an agent and the agent sending its opinion. This forms an abstract loop between agents that leads them to, on average, listen to and join identities that are similar to its own.

Changes in opinion are not just influenced by the identity of the sender however. If an agent is going to change at all, it is in the direction of the gap between the sender's opinion and its own. As these changes occur over time, the agents tend to move toward particular identity norms. The amount of change is also governed by the amount of certainty an agent has in its current opinion. This certainty builds over time as an agent receives more and more outside information. As the amount of information of a given opinion declines an agent's certainty may also decay.

Mechanisms for Identity Change

As noted, in social identity theory (Tajfel & Turner, 1979), a person identifies with a group in order to improve self esteem (Tajfel & Turner, 1979) and increase certainty (Hogg, Sherman, Dierselhuis, Maitner, & Moffit, 2007) about his/her identity. To that end, people join those groups which (1) have an opinion similar to the person's opinion along the salient category, (2) have a relatively high status compared to other

groups along the salient category, and are (3) permeable enough to allow the person to identify with the group.

There is a positive feedback loop with identity. A person identifies more with a group if s/he likes the group and identifies less with a group if s/he dislikes the group. A person's affect towards a group is determined by the amount of self esteem and certainty a person gains by being a member of the group.

A person gains self esteem in a group by comparing the group status to the status of other groups along some category of comparison, comparing his group to its past status, or comparing the group to some outside standard. If a person perceives the group status to be lower than what is expected, s/he will feel a sense of relative deprivation (Brown, 2000). This relates to the identity dimensions of cognitive centrality and ingroup affect.

The third dimension of identity, ingroup ties, is related to permeability. Permeability determines how easy it is for a person to increase and decrease the identification with a group and the upper and lower levels on that identification. Identity change occurs within the model. For example, a man cannot easily identify himself as a woman or totally get rid of his identification as a man.

Since a group is simply a set of individuals with various opinions, a person uses the cognitive construct of a group prototype to think of a group

as one entity with a set of “prototypical opinions” for the purpose of evaluating how close the group’s opinion is to that of the person along the salient category of comparison. One evaluates the prototypical opinion of a group against one’s own opinions. The groups whose opinions are closest to one’s own will be the group with which the person will identify his/herself (Hogg & Grieve, 1999; Abrams & Hogg, 2004; Hogg, Sherman, Dierselhuis, Maitner, & Moffit, 2006).

Mechanisms for Opinion Change

The mechanisms of opinion change in the SCIPR model are based on social influence and bounded confidence models. Social influence occurs when there is contact between a message sender and a message receiver. Either the sender or the receiver may initiate the communication. The message sender attempts to communicate a position about an opinion to the sender. As a result of this conversation, the receiver of the message may shift his/her opinion some distance towards or away from that of the sender’s opinion. Additionally, the receiver may decrease his/her uncertainty about an opinion that changes as a result of the conversation.

In continuous opinion dynamics models, the larger the gap between sender and receiver opinion, the less the receiver changes his opinion to match that of the sender. The uncertainty of the receiver influences the effect of the gap between sender and receiver opinion on the change in receiver opinion. Bounded confidence models portray receiver opinion as a point along a single dimension in some category of opinion.

For example, there may be a category called attitude toward political figure, which exists as a set of values along one dimension. At one end of the dimension is strong attitude against the political figure. At the other end of the category is strong attitude for the political figure. Each agent in the bounded confidence model will have an opinion of the political figure.

Furthermore, this opinion is held with a certain degree of confidence (or strength). This confidence is usually represented as either a symmetrical or asymmetrical set of thresholds. This confidence impacts the ability of the receiver’s opinion to change. If the sender’s opinion of the political figure falls beyond the thresholds of the receiver’s opinion, then the receiver will not change his/her opinion about the political figure toward that of the sender. When

this happens, the receiver either does not change his opinion at all and ignores the sender, or moves his opinion away from that of the sender.

As an example, suppose the dimension of for/against the political figure is from -1 to 1, with 0 as indifference towards the political figure. The receiver has some opinion about the political figure, say +.5 that says that s/he is moderately in favor of the political figure. The receiver also has a set of thresholds around this opinion representing his/her certainty about this opinion. One threshold is at -.1 and the other is at +.7. The closer the opinion of the sender is to +.5, the more the receiver will be influenced by it. As the sender’s opinion moves towards the receiver’s thresholds (from +.5 to -.1, for example), the receiver is less likely to be swayed to the opinion of the sender. If the sender’s opinion is outside the receiver’s thresholds (less than -.1, for example), the receiver will either ignore a social influence attempt by the sender, or will shift his/her opinion away from that of the sender. If the sender’s opinion is -.2, the receiver will either keep his/her original opinion or change his/her attitude to the political figure (by moving it from +.5 to +.7, for example).

When a receiver moves his/her opinion as the result of social influence, the thresholds move to re-center around his/her new opinion. Some bounded confidence models also suggest that after a change in opinion, the receiver’s opinion strengthens and the thresholds around that opinion tighten. So, if the receiver starts with an opinion of +.5, and thresholds of -.1 and +.7, s/he may move his/her opinion to +.7, shift the thresholds to center on the new mean, and tighten them, for example to +.3 and +.8.

Other aspects that impact the proclivity of opinion change are the frequency of communication between sender and receiver and the propensity of the receiver to listen to the sender’s message (Wasserman & Faust, 1999). These variables are, in turn influenced by the structural properties of the network ties between sender and receiver (and the structure of the network in general) and the similarity between sender and receiver. In his model of social influence, Friedkin (1999) suggests that a receiver is more likely to change his opinion to that of the sender if (1) the sender and the receiver occupy similar positions in the network, (2) the sender and the receiver are members of the same subcomponent of a network (a collection of people who have many mutual ties with each other, but not others in the network),

and (3) the sender has a high degree of structural centrality in the network.

Related to these concepts, social identity theory (Tajfel & Turner, 1979) holds that the more similar the social identities of the sender and the receiver are (along a salient category), the more likely the sender is to listen to the opinions of the receiver. This suggests another feedback mechanism. Since a person tends to identify most with those groups that have members with similar opinions to the person, it is logical that a person will listen more to fellow members than non-members, regardless of opinion. What this means is that if a sender's opinion is very different than that of the receiver, the receiver is more likely to listen to the sender's opinion if the two share a salient identity.

SCIPR Application & Usage

As noted, SCIPR is a software tool for predicting the reactions of a population to events. In SCIPR, agents representing proportions of the population of interest change their identities and opinions in response to events. These changes occur in line with Social Identity and Social Influence theories. An advantage of the agent-based approach is found in its modularity, its reusable structure. That is, while the data and parameters a user puts to the model must be specific to a particular country or region to generate meaningful results, the same model can be used for a different country or region. In other words, a different country requires different data, not an entirely new modeling approach.

To this end the first step when using SCIPR is to input data from the population into the structured database. The majority of this data represents census data. That is it is data is used to create a proportionately representative population of agents in terms of number of identities agents with certain identities and combinations of identities (e.g., Protestant male living in DC). In addition, baseline data is input regarding the opinions that are held by the cultural identities as well as degree of reactions that will occur to certain event categories. Finally, a static contact network is assigned based on geographic distance to other people, with a user-selectable power function that generates more associations to people that are closer geographically to the agent's location.

Once the regions and population have been created the SCIPR model begins execution,

reporting changes back to the database for the specified periods and duration. During execution agents periodically select a random contact from their network to exchange opinions. The events or courses of actions entered into the scenario also fire off at their specified times triggering additional opinion reaction evaluations for the people in the related region.

These influence triggers lead to thousands of interactions between the agents and events that evaluate changes in opinion and social identity using the theory described previously. These changes are recorded back to the database for further analysis and reporting. Each of these processes follows a carefully designed methodology that seeks to maintain a balance between a sufficient level of detail and a manageable level of complexity. The model behavior is the result of the integrated social dynamics of identity and opinion change. The agent population is only a fraction of the actual population being studied, yet the initial identity and opinion makeup remains proportional to what is observed through census data and surveys. Each agent therefore maintains information about its identities, opinion, and the social network it interacts with.

The behavior of the SCIPR model is observed by recording the individual changes in opinion and identity affiliation. These results can then be aggregated and sorted to identify interesting trends in a population's opinions and identity makeup.

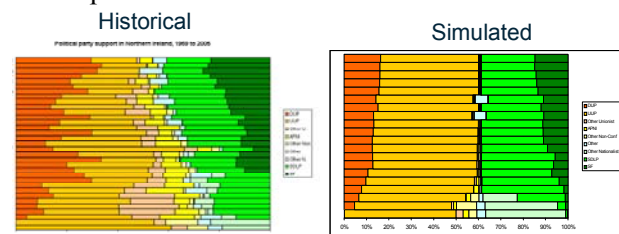


Figure 2. Comparison of historical data and SCIPR output for results of elections in Northern Ireland over time.

Simulations of the SCIPR model have shown a wide range of possible behaviors from populations of differing composition, initial opinion states, and ongoing events. Different case studies have demonstrated reasonable approximations the broader trends in a population. The most notable of these case studies is that using the historical example of Northern Ireland. This case study was accomplished using the CAIN (Conflict Archive

on the Internet) database, which contains census, election, and polling data for the duration of the Northern Ireland Conflict. It also contains a historical record of every sectarian killing that occurred. This data was entered as described, in the previous section, with events being the sectarian killings. The output of the model in terms of political party affiliation were compared to the historical elections. As can be seen in Figure 2, the model output clearly shows similar trends as to what occurred in Northern Ireland elections.

Conclusion

The U.S. military is currently struggling in the “battle for hearts and minds.” To win this battle they need to be able to better predict the reactions to events and sequences of events. SCIPR (Simulation of Cultural Identities for Predicting Reactions) is a model that can help them in this effort. The theoretical basis of SCIPR is the theories of Social Identity and Social Influence; two of the most well researched and supported theories in the social science. Further, the modeling approach of SCIPR based in solid research of bounded confidence models. Finally as an agent based model, SCIPR is a highly flexible tool that can be used in several different countries. Unlike other modeling approaches for cultural dynamics one need not instantiate new algorithms.

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ICCCD 2008 Proceedings

This paper was published in the *Proceedings of the Second International Conference on Computational Cultural Dynamics*, edited by V. S. Subrahmanian and Arie Kruglanski (Menlo Park, California: AAAI Press).

The 2008 ICCCD conference was held at the University of Maryland, College Park, Maryland, USA, 15–16 September, 2008.