Modeling the Interaction Between Leaders and Society During Conflict Situations

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Abstract

This paper describes an effort by Sandia National Laboratories to model and simulate populations of specific countries of interest as well as the population's primary influencers, such as government and military leaders. To accomplish this, high definition cognition models are being coupled with an aggregate model of a population to produce a prototype, dynamic cultural representation of a specific country of interest. The objective is to develop a systems-level, intrinsic security capability that will allow analysts to better assess the potential actions, counteractions, and influence of powerful individuals within a country of interest before, during, and after a conflict event.

Key Words

Societal Modeling, Leader Modeling, Conflict Modeling, Cognitive Agents

Societal Assessment Capability

The US is finding itself increasingly engaged in the development of unconventional partnerships that require a variety of non-traditional activities to better execute Theater Security Cooperation (TSC) activities in support of political and economic stability in regions of interest. The objective of this project is to develop a prototype tool to help personnel better determine the scope and type of decisions needed for shaping activities. This will be accomplished through enhanced knowledge of individuals acting within region/country-specific cultural behaviors and values.

Sandia National Laboratories (Sandia) intends to build a prototype cognitively driven computational modeling and assessment capability that will assist in forecasting attitudinal and behavioral reactions to US policies for a given country, group, or ethnic region. This will be accomplished by modeling the reaction of a representative population of interest to naval force activities across the spectrum of shaping activities.

The goal is to ultimately permit assessment of shaping activities and naval operations in an operational environment—which will also support optimizing force structure and capability. The objective of the proposed prototype assessment tool is to allow analysts to pose "what-if" queries concerning hypothetical policy and military initiatives to help determine how and why a population may react to a specific event, leader, or operation across time. We seek to create a system that can help an analyst better understand the interaction between leaders and local societies and how allegiances are formed and changed over time.

Sandia will utilize its extensive technical expertise in Modeling & Simulation (M&S) to create a social simulation platform that couples High Definition Cognitive Models (HDCM) with a cultural, economic, and policy-based simulation. HDCMs are purposely designed to computationally represent the mindset of specific individuals, including their perceptions, goals, emotion states, and action intentions.

The actions of one HDCM can affect the mindset and actions of others, as well as the general mindset of the society in which they are situated. The society, computationally represented in this initial effort by Sandia's Systems Dynamics-based Aggregate Societal Model (SDASM), can, in turn, affect the actions of the HDCMs (see Figure 1).

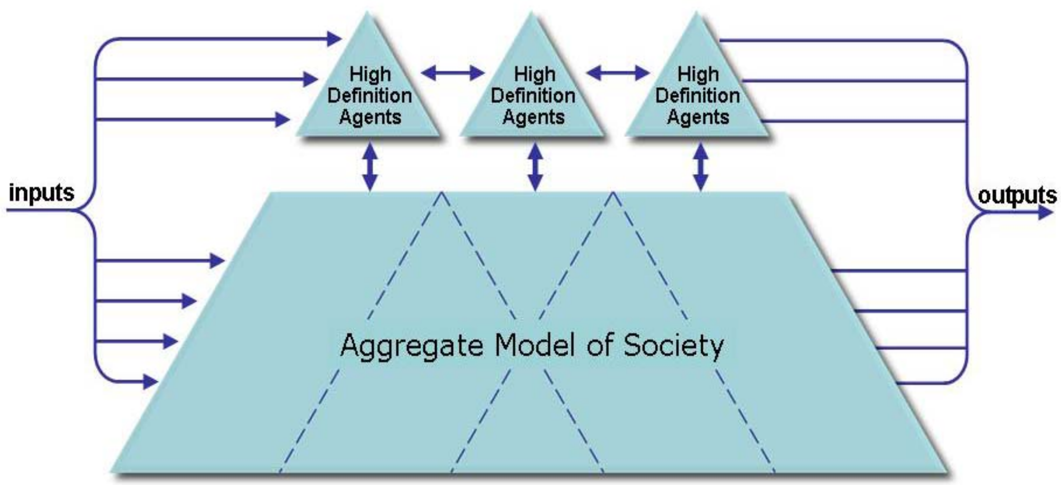

Figure 1. A conceptual view of Sandia's High Definition/Aggregate Societal

The Modeling Framework

The HDCM is focused on individual or group level of analysis, whereas the SDASM is focused at an aggregate level social, economic, and cultural level of analysis. These capabilities will be joined to provide a high-fidelity, scaleable assessment tool of individuals, small groups, and society to produce outcome distributions investigating attitudinal and behavioral reactions to US policies for a given country, group, or ethnic region. Both capabilities were developed under internal Sandia research funds. Thus, the intellectual property is unencumbered.

High-Definition Cognitive Models

As stated, the HDCM agents can represent the goals, perceptions, and dynamic emotion states of specific individuals, or types of individuals that interact with each other and their environment in a psychologically plausible manner. To achieve this, the HDCMs are based on robust psychological research and theory. Accordingly, an important feature of the framework is its primary emphasis on psychological realism. In this way several different types of individuals (e.g., government or group leaders) can be represented who may be generally similar to one another, but who exhibit differences in attitudes and behavior.

This realism is achieved by two means. First, the underlying cognitive processes that are modeled are based on recent advances in cognitive neuroscience, decision theory, sociology, and economics. Second, HD agent models are data driven. Data can come from subject matter experts, intelligence reports, the media, as well as other sources. The HDCMs consist of a human-representative computational model through which a HD agent recognizes patterns of stimuli in the environment and responds to those stimuli according to current contexts. As an HD agent perceives its environment, its perceptions are influenced by a hierarchy of higher-level goals or moral states, as well as emotion states (see Figure 2). The resulting behaviors conform to the *theory of planned behavior*, which maintains that behaviors are influenced by attitudes towards a specific behavior, the subjective norms associated with acting out that behavior, and the perception that this behavior is within a person’s control. This forms an action intention state, which then typically drives that person’s actual behavior (Ajzen & Madden, 1986; Fishbein & Stasson, 1990; Madden, Ellen, & Ajzen, 1992). This type of high-fidelity representation can capture and express the basic processes of individuals (e.g., leaders, terrorists).

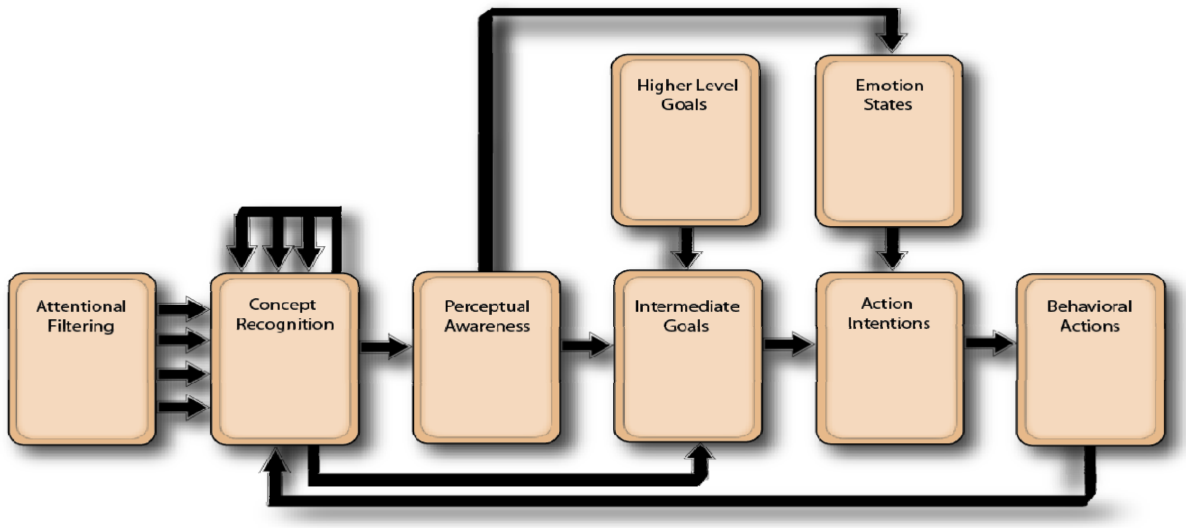

Figure 2. The process diagram of the cognitive actions within the HDCM framework

Systems Dynamics-based Aggregate Societal Model

The SDASM consists of a calibrated, systems dynamics/socio-political framework with behavioral decision simulation within populations and governments. It incorporates cultural, institutional, economic, and political distinctions. SDASM includes logic for detailed intra- and inter-regional interactions, as well as aggregate rest-of-world feedback dynamics. A calibrated framework combines selected economic data and societal index sources to allow model parameterization and long-term global modeling capability. Currently, no existing macroeconomic or societal model addresses security dynamics or coordinated kinetic and non-kinetic intervention. Methods developed at Sandia, combined with new verification and validation approaches under development at Sandia can, however, provide robust behavioral-response simulations [2, 14]. The foundation of these methods come from Nobel Prize winning work of Daniel McFadden on Qualitative Choice Theory (that accurately portrays human decision making) and by Clive Granger on Cointegration (that determines those variables which affect decisions with enduring or transient significance).

The physical and economic behavioral implications are readily simulated using basic aspects of conventional simulation methods such as System Dynamics [14], engineering [9], and economics [11]. Societal and economic realities are the consequence of behavioral decisions. The simulation and understanding of these processes is only recently possible. Decisions are the process of making choices. All behaviors are the consequence of choices made. McFadden pioneered the use of (psychologically framed) qualitative choice theory (QCT). QCT [13] is actually very quantitative and determines the importance people place on information, tastes, beliefs, and preferences when making decisions. The robust parameterization of QCT is often based on data readily obtainable in the field. Other techniques can further determine the correct functional representation of the QCT utility formulation for the problem at hand [10].

A key part of the decision process is the filtering of information and the extent to which experience biases the decision process. At a group level, the probabilistic nature leads to a mean-value response because random variation in one direction by one person is balanced by the reverse variation of another person. The enduring aspects of the population (society) dominate the group behaviors. The identification of the transient and stable components of the decision process use cointegration (also Granger Causality) methods pioneered by Granger. These same methods also ascertain the filtering and delayed-response processes associated with information perception and behavior [5, 6]. These methods and others are summarized in Backus [2] and [4]. These techniques can integrate disparate perspectives and information, qualitative as well as quantitative, into analysis and decision support systems. The methods are compatible with orthodox macroeconomic assumptions and used for all matter of choices (including those associated with security).

Societal Assessment Prototype

Applying the techniques and models discussed above Sandia has produced a prototype societal assessment capability that shows (1) potential actions, as well as the psychological processes behind those processes, for specific individuals of interest; and (2) potential societal actions in response to the actions of the individuals of interest as will as exogenous variables. In the system, the inputs to the HDCM/SDASM system will be cues associated with environmental events, US actions, and other external forces. These cues can be actual events, or be posed by analysts it create “what-if” scenarios. The cues will affect the HDCM by creating perceptions that are particular to a specific HDCM agent. The resulting cognitive states and actions will serve as inputs to the SDASM. The SDASM will represent the society in which the HDCM agents wield influence. The SDASM will receive the same cues as the HDCMs, as well as other cues that affect societies at an aggregate level. The output of the SDASM will serve as additional cues to the HDCMs.

When fully implemented, it is believed the combined interactions will capture the dynamics, secondary effects, and potential unintended consequences so as to better assess/develop interventions and regional-stabilization conditions. Figure 3 shows an example of this process for a single individual as well as the interaction between the individual and the societal model. Incoming information will activate specific concepts (shown in red) to represent specific modeled psychological processes. Potential actions will be fed to the SDASM, which will, in turn, activate concepts that will be fed to the HDCMs. The interactions from this process are then visualized in a graphical interface.

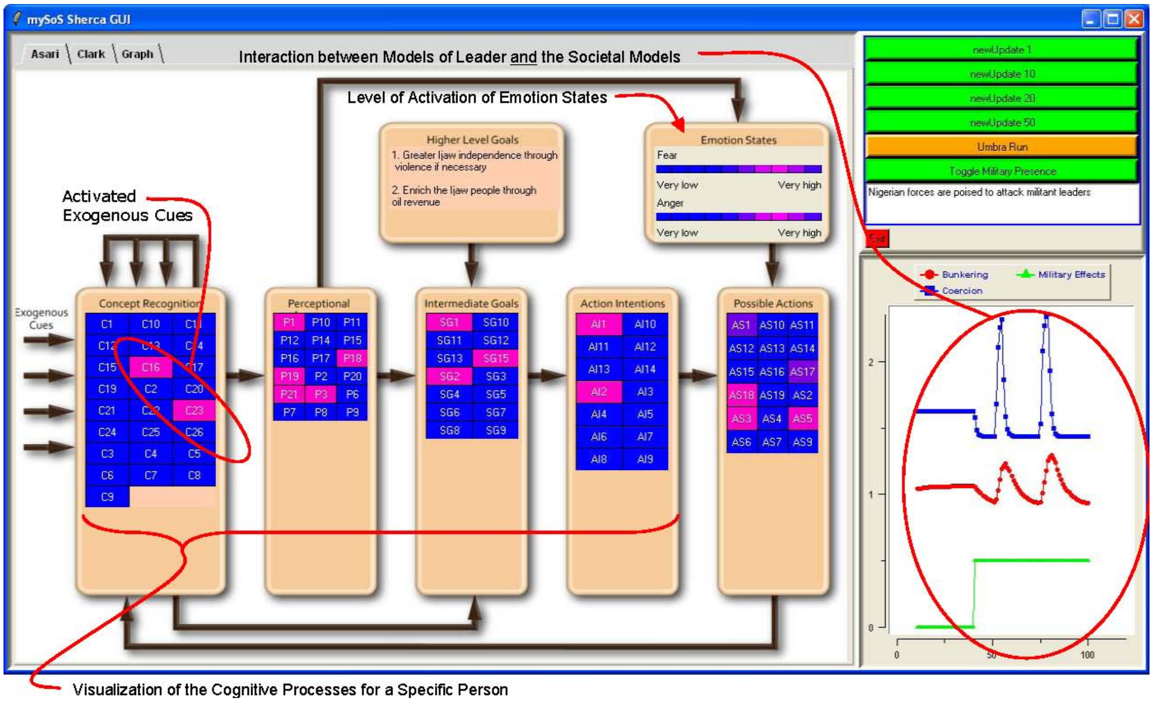

Figure 3. An example of the output of the prototype societal assessment tool.

Conclusion

These explorations indicate the value and viability of combining cognitive models to represent individual leadership with System Dynamics models to simulate groups and societal interactions. The demonstration model also shows it is possible to design a model that does allow field data for parameterization (and thereby allows validation testing/modification) of the model. While the qualitative results shown here are possibly intriguing and plausible, the use of normalized parameters and unsubstantiated assumptions means that there is, as yet, no legitimacy to quantitative results.[1]

Confidence in model results/recommendations would require client supported data efforts, SME review, and formal model validation and verification. The initial prototype uses a simpler societal model SDASM to explore and gain understanding of the problem domain. In further stages of the project, more complex systems dynamics models and other modeling approaches, such as agent-based models, will be utilized as needed. A US policy or other directives proposed by the sponsor will be modeled to forecast change in aggregate behavior. This will permit large-scale simulations that model societies and sub-groups reacting to hypothetical US actions prior to an engagement. This initial capability could make significant headway in the ability to better understand and forecast attitudinal and behavioral responses at a regional, national, or local level. Specifically, the attitudes and actions of a given population would be modeled and simulated

[1] Next stage efforts should certainly include a form regimen of verification and validation testing.

before, during, and after a political and/or military action has been imposed on them by the US or its allies.

Past attempts at assessing conflict initiation and evolution have depended on quantifying static conditions, such as poverty or ethnic majorities—with minimal success. New methods that address the behavioral dynamics and expectation formation appear to show much promise. Enhancing macroeconomic models to include endogenous security metrics and adding behavioral dynamics should produce a reliable tool set that Sandia and the nation can use to address emerging and evolving threats. Such an approach could simulate the impending dynamics, delineate the complex social-behavioral phenomena, and determine intrinsically secure engagements that alleviate the cascading, unintended consequences that cause enduring global destabilization.

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