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# Team 9: Representing Urban Cultural Geography in Stability Operations (RUCG-SO)

## TEAM 9 MEMBERS

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## INTRODUCTION

Representing Urban Culture Geography in Stability Operations concerns the representation of the civilian population in a conflict environment. This working group used a scenario developed for Pythagoras and a scenario developed for a prototype multi-agent system model of the civilian population to explore the response of the civilian population to insurgent, government and stability force actions in a counterinsurgency environment. The working group also examined potential measures of merit from recent work by an irregular warfare modeling and analysis working group.

This article describes the effort associated with the prototype multi-agent system model of the civilian populace with a focus on developing the data associated with a notional scenario to execute the model in a high performance computing environment with an experimental design. The ultimate motivation behind the multi-agent system model is to create a scenario and run the simulation model to understand how actions, information, perceptions and beliefs affect public opinion about the legitimacy of the host nation's government. This workshop was the first test of that emerging model.

## MODEL

The version of the prototype used during the workshop had limited initial functionality consisting of civilian population entities, select beliefs and positions held by those entities, the social network connecting the population entities, and a set of actions influencing the population entities.

Civilian population entities represent typical members of the society. They may represent individuals, families, clans or tribes depending on the resolution desired and the data available during scenario development. Civilian population entities are cognitive agents in the multi-agent system. Most other agents like the stability forces, host nation entities, insurgents, and others are reactive agents consisting of relatively simple scripts to represent plans and simple behaviors to represent policies in response to actions.

Central to the civilian population entities are the positions they hold on matters of public importance and the underlying beliefs that support those positions. These agents

process information about events in the model and about objects in the environment that they observe. This information influences their beliefs and positions.

Civilian population entities are directly influenced by action events and indirectly influenced by other agents in the social network. Action events take the form of positions on an issue along with beliefs associated with that issue. The social network connects the population entities and provides for the exchange of information among entities. When a population entity processes an action influence the agent may decide to pass it along to one or more agents in its social network.

## SCENARIO

The scenario was derived from the Peace Support Operations Model (PSOM) Ginger Junction scenario used in the MORS Irregular Warfare (IW) Workshop in December 2007. That scenario is a disaster relief operation complicated by an active insurgency. The RUCG-SO Ginger Junction scenario follows the broad outline of that scenario with scripted behaviors and events for most actors and an enhanced focus on the civilian population's response.

In total there were 86 population entities distributed across four population groups: Northern Natives, Northern Others, Southern Natives and Southern Others. The social network represents affective ties in the population. The existence of a relationship is symmetric, but the strength of the relationship is not symmetric.

Issues identified in the Ginger Junction scenario include Southern Independence, Land Reform, Increased Crime, Distribution of Disaster Relief Aid, Distribution of Wealth, Representation in Legislature, Participation in Government, and Government Mismanagement of Budget. For this experiment two representative and related issues, Southern Independence and Land Reform, were examined.

The issue of Southern Independence has four possible positions: Status Quo, Federalism, Autonomy and Independence. This issue is influenced by three population entity beliefs: fairness of political participation, belief that southern natives (called Little Buddies) are inferior, and views on the role of government.

The issue of Land Reform has three possible positions: Status Quo, Minor Reform (e.g., making land available for ownership by the poor, squatters, etc.), and Major Reform (e.g., redistributing land or government control of land, etc.). This issue is influenced by two population entity beliefs: legitimacy of current land ownership and perceptions about the current plantation system.

Figure 1 is an example of the initial beliefs and positions of an agent depicted as a Bayesian belief net. We used Netica 4.02 by Norsys Software Corporation for this research relying on the graphical user interface for data development and using the Java Application Programmers Interface (API) in the multi-agent system implementation.

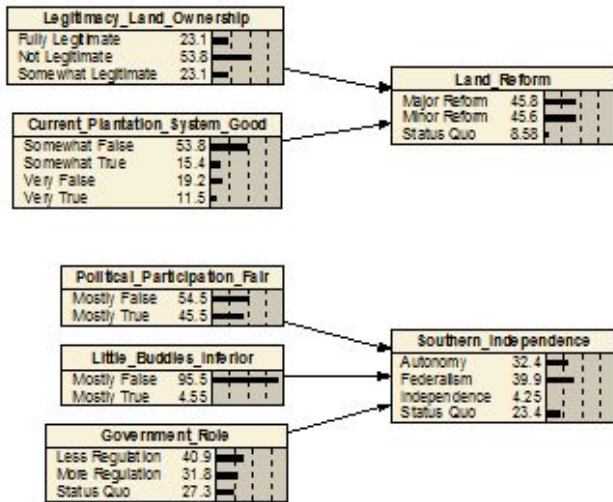


Figure 1: Southern Native #15 Initial Beliefs and Positions (using Netica 4.02 by Norsys Software Corporation).

The underlying data for this belief net was derived by taking a set of representative survey data for the individual agent’s population group and randomly selecting a subset of the survey results for this agent. Each case in the survey data represents the response from a single member of the population surveyed on his issue position and related belief stances. This method of random selection from within an agent’s population group produces agents representative of the group with a reasonable distribution of beliefs and positions.

It is important to note that the agent’s position on issues and stance on beliefs is not like a single response to a survey. Instead one may interpret the internal representation of the agent’s issues and beliefs in a few ways. First, you might consider the agent as an individual and view the weighting on issue positions or belief stances as his tendency to support that position. In a simple case like Southern Native #15’s belief that Political Participation is Fair we observe that his initial belief is balanced between Mostly False at 54.5% and Mostly True at 45.5%. That agent leans slightly toward Mostly False.

Second, we might consider the agent as representing more than one individual with the weighting of each belief stance representing the proportion supporting that stance. As a practical matter, the model will use the data associated with beliefs and positions in the same way.

The events in the scenario are in the form of effects, which we call action influences because they translate actions in the scenario into their influence on population entity beliefs and positions. Each action influence supports one set of beliefs and one issue position. Table 1 is Action Influence #198 depicted as a data table in the form that is processed by the

model. This Action Influence supports the status quo for land reform based on the belief in a fully legitimate system of land ownership and the goodness of the current plantation system. Note that this example has data for the issue position and stances on both related beliefs; however, the multi-agent system implementation can process action influences that consist of partial information.

Legitimacy Land Ownership	Current Plantation System Good	Land Reform
Fully Legitimate	Very True	Status Quo

Table 1: Action Influence #198 as a Data Table for Processing by the Model.

The weight of the action effect depends on the strength of relationship between the influenced agent and the influencing agent in the social network. In the experimental scenario there are 200 candidate action influences. The number and type included in each scenario depends on the action influence factor setting. In Versus there are 140 action influences; in Neutral there are 144 and Equal there are 149.

An action influence is directed at one or more of the four population groups. Of the 200 candidate action influences, 27 target the entire population, 42 target the Northern Natives, 40 the Northern Others, 66 the Southern Natives and 25 the Southern Others. Forty-two action effects occur in only one design point; 83 in two; and 75 in all three. All Land Reform action influences occur in all three design points.

## EXPERIMENTAL DESIGN

The experimental design had two factors each with three settings configured in a full factorial design as depicted in Table 3.

Design Point	SI Action Influence	Social Network Density
DP01	Neutral	High (Base)
DP02	Versus	High (Base)
DP03	Equal	High (Base)
DP04	Neutral	Medium
DP05	Versus	Medium
DP06	Equal	Medium
DP07	Neutral	Low
DP08	Versus	Low
DP09	Equal	Low

Table 2: Experimental Design.

The first factor was action influences for Southern Independence. We varied the distribution of action influences in the scenario. In the Neutral factor setting action influences support each of the four positions in the same proportion as was initially found in the overall population. In the Versus factor setting action influences supporting the two extreme positions, Status Quo and Independence, were increased to account for 90% of the influences in equal weight with the remaining 10% of the action influences supporting the two centrist positions, Federalism and Southern Autonomy, in equal weight. In the Equal factor setting action influences supporting each of the four positions were the same.

The second factor was density of the social network. The Base factor setting has the baseline social network, which is relatively dense. The Medium factor setting is about half as dense as the baseline social network. The Low factor setting is about a quarter as dense as the baseline social network. While

a population entity is more likely to have more and stronger ties in the social network with members of the same population group, social ties cross population group boundaries.

## **RESULTS AND CONCLUSIONS**

We successfully executed ten replications of each of the nine design points in the experimental design after making some fine tuning adjustments to the model and data. Data was collected on each state change for each agent. Analysis of the resulting data indicates that the multi-agent system model functioned as expected.

Varying the Action Influences related to Southern Independence resulted in significantly different issue positions on Southern Independence in line with the nature of the distribution of action influences. Neutral had only a minor impact while Equal and Versus had more of an impact and moved the issue positions toward the expected results.

Varying the Social Network Density resulted in significantly more state changes in the design points with a denser social network. The resulting movement in issue positions was more pronounced in dense networks than less dense social networks. We noted that the model was sensitive to the probability that an agent passed along an action influence in his social network.

Not varying the Action Influences related to the Land Reform issue served as a useful control on the experiment. The expected response occurred with little difference among design points with the same social network density and statistically significant differences between design points with differing densities.

This experiment is the first experience with the multi-agent system. It provides a sound basis for continued testing and development of analytical methods going forward. Over the next year, the multi-agent system will be significantly enhanced to better represent civilian populations in stability operations based on social science theory.