

Agent-Based Modeling with Social Networks for Terrorist Recruitment

Teresa H. Ko and Nina M. Berry

Embedded Reasoning Institute
Sandia National Laboratories
{thko,nmberry}@sandia.gov

Abstract

The Seldon model combines concepts from agent-based modeling and social network analysis to create a computation model of social dynamics for terrorist recruitment. The underlying recruitment model is based on a unique hybrid agent-based architecture that contains simple agents (individuals such as *expatriates*) and abstract agents (conceptual entities such as *society* and *mosques*). Interactions between agents are determined by multiple social networks which form and dissipate according to the actions of the individual. We have implemented a Java-based toolkit to evaluate the dynamics of social behavior and the specific dynamics associated with terrorist recruitment described by expert social scientists, creating an architecture for simple adaptation to other group phenomenon.

Introduction

The Seldon project takes its name from Hari Seldon, the fictitious originator of "psycho-history" in Isaac Asimov's Foundation stories. In those stories, Seldon was able to employ a deep knowledge of history, the social sciences, and mathematics to forecast large-scale and long-term trends in the development of civilization. Only large-scale forecasting was possible; in fact, the major tension in the stories stems from the unexpected role of a single unique individual, born long after Seldon's death, who threatens to disrupt Seldon's calculations and destroy the plans he based upon them (Berry *et al.* 2003).

Today, psycho-history remains a science fiction fantasy. However, computational tools are now emerging that allow short-term modeling of tightly-constrained, complex social interactions. Unlike psycho-history, these tools cannot reliably be used to predict the future. Nevertheless, they may illuminate dynamics that can help us anticipate the broad consequences of the complex interactions of social forces that will arise in our efforts to combat terrorism.

We present a terrorist recruitment model based on a unique approach to computational social simulation by combining both agent-based modeling techniques and social networks analysis in order to capture the underlying social dynamics of terrorist recruitment.

Our Model

The model consists of agents and the social networks that bind them together. The model contains two categories of agents: individual agents, a traditional computation agent used to represent a human, and abstract agents, a conceptual agent used to incorporate social concepts into the model. The terrorist model has two types of individual agents: an *expatriate*, a foreign national who is isolated from the community and terrorist organizations, and a *bridge*, a foreign national who has the ability to connect an expatriate with a terrorist organization. The three types of abstract agents are the *society*, the *mosque*, and the *clique*. The *society* captures the culture in which these agents reside encompassing societal concepts such as the willingness to accept foreigners in their world. The *mosque* represents the religious and social gathering place for expatriates. The *clique* encapsulates the group dynamics of individuals who are all close friends with one another.

Individuals belong to social networks which vary dynamically from day to day. There is a prevalent world network which all individuals are a member of and smaller networks derived from past interactions and abstract agents. There are five networks within our model: the *world* network (which connects everyone together), the *mosque* network (which connects an individual with other individuals attending the same mosque), the *acquaintance* network, the *strong bonds* network, and the *clique* network (which all captured different levels of relationships between individuals). By varying an individual's interactions within different networks, the types of friendships that form (i.e., within a mosque vs. throughout the world, the number of bonds vs. the strength of the bond) illuminate the underlying dynamics of different social scenarios.

We have used homophily as an underlying mechanism for bond formation and stickiness to an abstraction. The more similar two expatriates are, the more likely they will create a stronger bond or reinforce an existing bond. This concept between simple agents has been extended further to capture how committed simple agents are to a concept. In this case, we used homophily between an expatriate and the mosque it is currently attending in conjunction with the homophily between an expatriate and their fellow attendees. If similar enough over time, an expatriate's commitment causes them to be virtual stuck to that particular mosque.

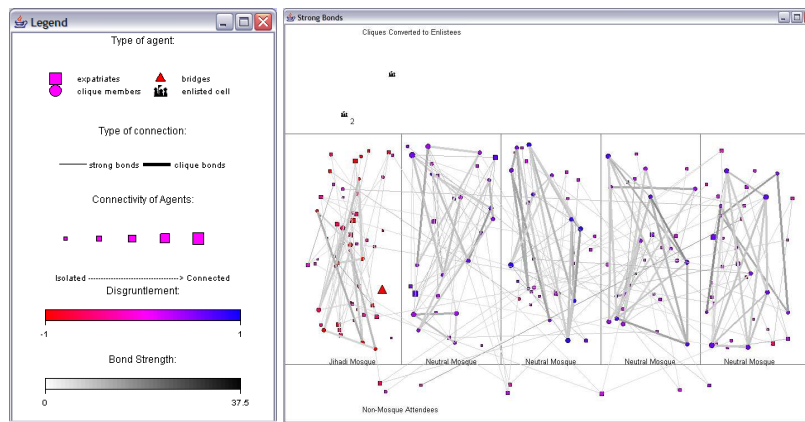


Figure 1: Snapshot of a simulation run. Expatriates are visualized by squares of varying size, representing their disgruntlement and relative isolation, respectively. Strong bonds are visualized by an edge where the strength of the bond is shown through the gradation of the edge. Cliques are distinguished from other agents by circles rather than squares and thick lines between members.

A Simulation

We have converted the research done by Marc Sageman (Sageman 2004) into a computation model describing a path for an expatriate to become an enlistee of the terrorist camps. Expatriates are initialized as neutral entities that are completely isolated. They flow in and out of different mosques attempting to find friends. Through random interactions within the world and the mosques, expatriates begin to form acquaintances with others similar to themselves. Over time, the bonds between some expatriates become strong enough to be considered friends. Cliques naturally begin to form among the expatriates. At the same time, the disgruntlement (a measure of dissatisfaction with the current living status) of expatriates changes through their interactions with the abstract agents and individuals. To enlist an expatriate into a terrorist organization, three things need to be true simultaneously:

- the expatriate must belong to a clique
- the clique must be disgruntled enough to consider a terrorist organization, and
- a bridge must be willing to confide to the expatriate its connection to the terrorist organization.

If all these conditions are satisfied, the entire clique is enlisted and journeys to a terrorist training camp.

Figure 1 shows a snapshot of a simulation run which contains expatriates in all stages of the path to a terrorist camp. In this simulation, there are 200 expatriates and one bridge. Expatriates can choose to attend five different mosques, a jihadi mosque which influences expatriates to be disgruntled and four neutral mosques which influences expatriates to be slightly above neutral. There is a sharp division between expatriates attending the neutral mosques and the jihadi mosque. In addition to being influenced by a mosque, an expatriate is also more likely to continue to attend a mosque that is similar to itself. These two aspects result in the jihadi mosque having very disgruntled attendees and the

neutral mosques having neutral to happy attendees. In this simulation run, cliques tend to form within a single mosque due to an expatriate's high percentage of time spent interacting with members of its mosque's network. The bridge has successfully converted two disgruntled cliques that originated from the jihadi mosque.

By varying the parameters of our model, we have investigated which dynamics have the greatest impact on reducing terrorist camp enlistment. Among the most effective means are creating a more tolerant city, reducing interactions within the acquaintance network, and increasing the requirements for establishing friendship.

Conclusion

We have presented a novel approach to agent-based modeling by incorporating conceptual agents which enable higher-level concepts while providing individual agents that exhibiting socialized behavior. We have merged the concept of multiple dynamic social networks into agent-based social simulations increasing the flexibility and accuracy of social simulations. These concepts have been applied to the domain of terrorist recruitment enabling greater understanding of the underlying dynamics of social behavior and possible mitigating strategies.

References

- Berry, N.; Ko, T.; Lee, M.; Moy, T.; Pickett, M.; Smrcka, J.; Turnley, J.; and Wu, B. 2003. Computational social dynamic modeling of group recruitment. Technical Report SAND2003-8754, Sandia National Laboratories.
- Sageman, M. 2004. Understanding terrorist networks. Technical report, University of Pennsylvania.