

Using a Hybrid Cognitive-System Dynamics Model to Anticipate the Influence of Events and Actions on Human Behaviors

Asmeret Bier, Michael Bernard, George Backus, Matthew Glickman, and Stephen Verzi

Sandia National Laboratories

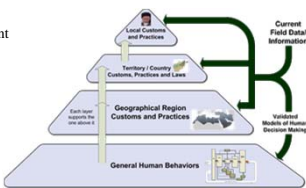
Introduction

This project was designed to give insight into potential actions and counter-actions that people within a society might take in reaction to internal and external influences (such as social, political, environmental, and military). The system dynamics model uses a cognitive modeling framework to determine human behavior.

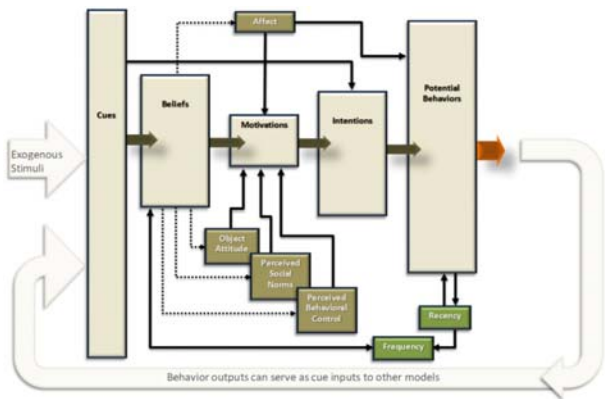
Cognitive Framework

The cognitive framework is based on a unique set of elements from psychological theory that are consistent with economic theory, experimental data, and historical data on human behavior. The cognitive framework uses established models of attitude, motivation, intent formation and change, social learning, qualitative choice, and volitional behaviors, and implements these in a system dynamics context. The framework:

- appears to comprehensively describe significant processes of human behavior
- includes cultural, biological, and institutional constraints and conditions
- can encompass
 - an unlimited number of entities
 - any number of alternative decisions
 - any level of interrelationship complexity

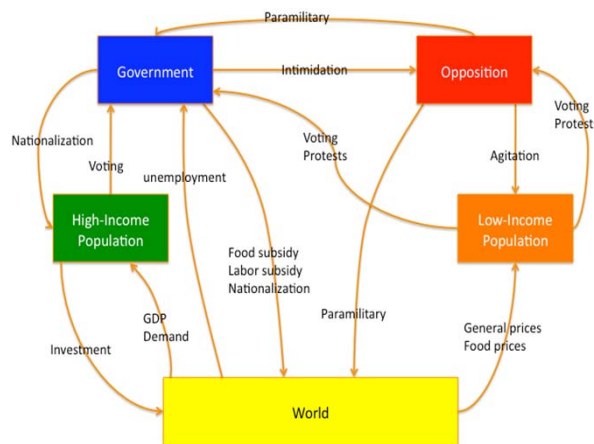


In the framework, signals created by the environment or by people's behavior can be received by cognitive entities as stimuli. Stimuli that are relevant to the decision-making process are perceived as cues that can stimulate a particular belief. The same stimuli may be interpreted differently by different people or groups. The stimulated beliefs, together with pre-existing attitudes and associated norms, perceptions of behavioral control, and affect (emotion), may motivate the cognitive entity to perform some behavior. If motivation is high enough and the behavior is actionable, the entity may form an intention to perform that behavior. The chosen behavior is a function of the intent, affect, external stimuli, and how often and how recently that behavior has occurred in the past. The result of this cognitive process is the entity's actions, which can go on to affect the political system.



Model Overview

The cognitive framework is embedded within a system dynamics model to determine the behavior of the people and groups that the model simulates. A separate cognitive model is populated for each cognitive entity (person or group). Environmental factors, such as economics, are also included in the system dynamics model. This cognitive-system dynamics framework is very flexible and can be altered to represent a large variety of systems. The diagram below is an overview of a proof-of-concept model that simulates political dynamics in a hypothetical society.

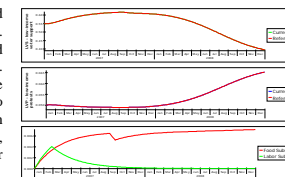


The cognitive framework is instantiated four times in this model, for the government, opposition, high-income population, and low-income population.

- The **low-income population** in this society makes its political decisions primarily based on prices of food and general goods. This population can take political action through voting and protesting, and might be encouraged to protest by the opposition.
- The **high-income population** is more interested in macroeconomic indicators like GDP and demand, and also pays attention when the government nationalizes industry. This population affects the political system through voting, but can also indirectly affect the system by investing in the society's economy.
- The **government** pays close attention to voting preferences, protesting, and unemployment. In order to keep voters happy, the government may implement subsidies for food and labor. It may also nationalize industry. If the government feels threatened, it might try to intimidate the opposition.
- The **opposition's** behavior is based on intimidation from the government as well as on voting and protests. The opposition may encourage protesting by agitating the low-income population. Finally, the opposition has the option of initiating paramilitary operations against the government.

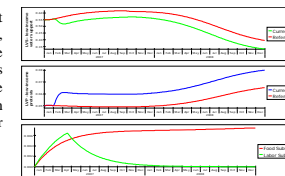
Results: Base Case

At the start of the simulation, protesting and support for the government are relatively stable. The government implements subsidies for food and labor to encourage an increase in support. Although food prices are suppressed by the subsidies, the government must print money to pay for the subsidies. The resulting inflation causes the price of general goods to increase, leading to a significant drop in low-income voter support and increase in protesting.



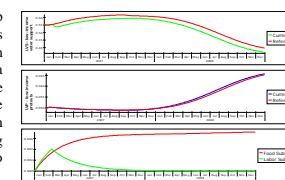
Results: Outside Support for the Opposition

In this scenario, an outside group provides support (in the form of money, resources, encouragement, or something else) to the opposition. When the opposition receives outside support, it increases the effort that it puts into encouraging low-income voters to protest. Protests increase, which decreases the low-income population's support for the government.



Results: Voter Information Operations

This scenario involves an outside group disseminating information to voters. This information is intended to discourage voters from supporting the government. This strategy has a small direct effect on voter support, but alarms the high-income population. They decrease investment in their society's economy, which affects GDP and the price of goods. Protesting increases slightly, which causes voter support to decrease.



Results: Outside Show of Force

When an outside group shows force against the society, the population becomes very patriotic. Support for the government increases and protesting drops. The high-income population becomes worried, so investment drops and unemployment increases. The government increases the labor subsidy to account for unemployment. Eventually the high-income population regains confidence and invests more, which reduces unemployment.

