Applications of Self-calibrating Hybrid Causal-Learning Systems to Opinion Dynamics Modeling

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The agent-based modeling in general and the opinion dynamics in particular reflect the fact that the dynamics of social and human systems arise as a result of many decision makers operating and making decisions with different degrees of autonomy. A key challenge in modeling such systems (and in application of the modeling insights) is that the decision-making process is never completely observable, and therefore the associated data regarding the state of the system is never complete. Yet, the interaction structure (the rules and constraints for executing decisions) and the causal structure (causal ordering of the events) of the system, are often observable. For example driving a car is generally restricted by the existing transportation infrastructure and laws.

Many agent-based modeling efforts attempt to represent all system components and interactions as completely as possible under the assumption that including enough data in such a model would sufficiently eliminate model uncertainty. This approach is unfeasible; instead we outline a hybrid causal-learning approach to create self-calibrating social system models.

We use the agent-based approaches to represent the inner system interactions, such as opinion updating, as a causal model; and learning algorithms to calibrate the causal model parameters and generate prediction error estimates. The key feature of this approach is the action/observation/learning loop: make predictions using causal models, observe actual outcomes, and improve causal models.

We demonstrate the effectiveness of this approach on an example of opinion dynamics on a network of heterogeneous agents. In reality agents may have vastly different strategies for updating their opinions, with much of this decision-making process being unobservable. We investigate using the outlined framework how different influence policies, such as educational campaigns, can be developed for such a population of heterogeneous agents. We show that even without complete information on the individual agent's decision-making rules, effective strategies for affecting the network's overall opinion can be developed. We investigate the game-theoretic aspects of competing strategies that attempt to move the network opinion.