Reasoning on Conflict and Negotiation Through Causal Maps

B. Chaib-draa
Département d'Informatique, Faculté des Sciences
Université Laval, Sainte-Foy, QC, G1K 7P4, Canada
chaib@ift.ulaval.ca

Causation is vital to the process of evaluating alternatives, particularly in multiagent environments where a *decision* involves reasoning about others' intentions. In these environments, agents do evaluate complex policy alternatives in terms of the consequences a particular choice would cause *locally* and *globally*. In this work, we propose a model which allows agents to reason on their causal assertions. The basic elements of this model are simple. The concepts an agent uses are represented as *points*, and the causal links between these concepts are represented as *arrows* between these points. This representation gives a graph of points and arrow, called a *causal map* or *cognitive map* (Axelrod 76, Zhang 96). The strategic alternatives, all of the various causes and effects, the goals, and the ultimate utility of the agent decision maker can all be considered as concept variables, and represented as points in the causal map. The real power of this approach appears when a causal map is pictured in a graph form; it is then relatively easy to see how concepts and causal relationships are related to each other and to see the overall causal relationships of one concept on another.

Generally, using a causal map (*CM*) includes the following ideas: (1) causal associations allow understanding about a global environment; (2) causation allows explanation of (past) events; (3) causation allows prediction of future actions; (4) causal evaluation is the major way of choice among alternative actions.

All these ideas are important in the context of multiagent where agents have to cope with problems of disparity and uncertainty between their causal maps, because each agent or a group of agents has a local view which is generated by its *bounded vision*. Interaction disparities and uncertainties can lead to conflicts between agents. To solve such conflicts, agents can use a negotiation process. In this work, we present an approach to the modeling of conflict and negotiation based on causal maps. Our approach first permits a rich and structured map of participants' perception to be constructed, and then allows the interaction between individual agents to be studied using 1) a model based on relational algebra, and 2) a derivative of hypermaps analysis.

We have also taken a first step toward a complete implementation of a reasoning mechanism based on causal maps. Precisely, we have implemented a tool called $\mathcal{SR}o\Psi lab$ that enables users to edit causal maps as matrices, to store them in a working memory, to execute relation algebraic operations on those matrices, and to test certain properties.

$\mathcal{SR}o\Psi lab$ is a library of functions developed to be used in the environment of Ψlab. The software Ψlab is a free-ware application (similar to MATLAB) which has been developed at INRIA (Institut National de Recherche en Informatique et en Automatique) in France. Ψlab is an interpreter offering many formal characteristics and possibilities, but it cannot manipulate relational calculus between symbolic statements. Our software $\mathcal{SR}o\Psi lab$ allows this type of calculus because it supplies Ψlab with symbolic calculus on relations.

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