Computational Organization Research

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Overview

A growing collection of communities worldwide is researching phenomena of human organizations using computational methods. There are pressing research issues in both the development and ongoing operations of organizations, and in organization theory and analysis, that are highly amenable to techniques for computational modeling, theory-building/testing, and experimentation. This short note is intended to provide a quick orientation and perspective on *computational organization research*, a phenomenon and problematic that has been the focus of this emerging research community, both within and outside of AI, DAI, and multiagent systems arenas.

Organizations and organization-level phenomena are already ubiquitous in modern life. New technologies and new social and institutional arrangements are emerging rapidly, changing our notions of what it means to be organized, how best to organize, how to form, change and stabilize organizations, and so on. The rapidity of these changes, and the growing body of information and knowledge involved in the functional and representational processes of modern organizations, mean that new methods, mechanisms, and theories are needed. Particularly *computational* methods may provide several advantages for studying and enhancing some kinds of organizational phenomena:

- Organization theory, analysis, and design problems can be hard partly because of the scale and complexity of both the objects of study (organizations, organizational processes, knowledge, etc.) and the theories themselves. By analogy, there are many recent initiatives on topics of modeling, analysis and simulation of large-scale physical and biological phenomena, such as airflows and the human genome, to better understand the relevant underlying structures and to solve particular configuration problems. The structural and configuration problems of organizations are at least equally impactful (socially-speaking) and at least as scientifically challenging.
- For the study of organizational issues, foundations of theory, modeling technology, and infrastructure is ready, and the impacts of improved effectiveness and flexibility of organizations could be great.
- Networks and concurrent-system technologies have made possible wide-area interactions and virtual organizations, and are beginning to support controllable interactive and mobile agents. These form the basis of both new organizational objects-of-study (e.g., literally "computational organizations"), and new simulation, experimental, and information-gathering technologies.
- Representation, and implementation technologies and theory have advanced to the point where we now have insightful and useful tools for theorizing about and modeling organization-level phenomena. These include coordination languages and algorithms, organization ontologies, computational organization theories, etc. (see, e.g., [1],[6],[7]).
- Advances in computer-aided design have also created useful tools that begin to bring computer aided *organization* design into reach. Computational modeling and evaluation of organization can support progress on computational organization design. Techniques of optimization, qualitative reasoning, iteration and search, developed for other applications, also support computational organization design [3],[4].
- High-powered desktop computing creates demand for generally-available tools for organization monitoring, analysis and design. These computers, along with very fast high-performance simulation capabilities on supercomputers, add the capability to do complex analyses with reasonable response times.
- The infrastructure that exists for such research comprises existing working collaborations among key groups, as well as transferable analytical and modeling software (e.g. experimental testbeds, declarative theories, sharable ontologies, interchange formats such as thoses for processes and knowledge, coordination languages and algorithms, etc.).

Computational systems for complex organization analysis do exist, and are in actual application or pilot use in major organizations, e.g. for organizational

design, analysis, re-configuration, re-engineering, and process change (See all references below). In addition, large research grants have been made to a number of research centers to study organization problems computationally. It has become clear through a set of recent meetings and publications that enough of an interdisciplinary organization-studies community has emerged, with enough familiarity with each others' work and enough basic interdisciplinary knowledge to make real inroads.

The Focus of Computational Organization Research:

Computational organization research can be examined along three axes:

Computational: The focus of this activity is explicitly *computational* approaches to organizational phenomena. Example areas include computational models and representations of organizational knowledge, explicit organizational ontologies, simulations of organizational activity or structuring, computational approaches to building organization theories, coordination algorithms, computational approaches to organization design, computational tools for organization analysis, and of course "computational organizations"—those organizations made up completely or partly of computational participants—as explicit objects of study and of design.

Organization: The locus of this activity is typically mid-range, organization-level phenomena–as versus theories of individual participants (e.g. cognition or psychology) or macro-scale phenomena (macroeconomic behavior, societal-level dynamics, institutional interactions). This line is hard to draw, however, and macro-mezzo-micro links are often of explicit interest, as are specific implications for agent-oriented and societal-level phenomena.

Research: The locus of this activity is primarily organizational *research*—that is, innovations in description, analysis, theory, and methods. It is clear, however, that much good organization research is driven by clear applied problems, and that the best practical organizational tools embody clear principles and theory. This line, too is hard to draw, and COR research may include issues in the practical application of organizational tools such as business process reengineering tools or enterprise integration tools.

Conclusion

Models, reasoning methods, and findings from the standard AI repertoire can be applied usefully and effectively in the enterprise of organizational research (e.g. [2], [5]). Conversely, models reasoning methods from organization research can be applied in the enterprise of AI as its boundaries expand more clearly into multiagent and distributed contexts. Together, these syntheses promise a fertile new ground for both areas to expand.

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