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Editorial

Computational and Mathematical Models of Organizations

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Human organizations, as social, cultural, scientific and business phenomena, are becoming more complex, more interconnected. The environments in which organizations exist are becoming ever more demanding and dynamic, and in fact the very nature and definition of what constitutes the modern organization is changing rapidly, with the introduction of such possibilities as virtual organizations and highly integrated but geographically dispersed enterprises. These considerations are having impacts, both substantive and methodological, on the content and structure of organization theory and practice.

Fortunately, along with the added complexity and accelerating dynamics of modern organizations, new tools for modelling and analysis of organizations and organization problems are beginning to emerge. Computational models have been a part of the world of organization theory since the pioneering work of Cyert and March (1963). More recently, mathematical tools, including those of logic, decision theory and probability, are becoming better equipped to handle situations of conflict, compromise and multiple agency. Similarly, modern computing methodologies, including formal techniques of

representation and reasoning, and practical experimental techniques of simulation and analysis are being coupled with computer hardware and networks of unprecedented speed and versatility. Taken together, the trend is toward an array of powerful new theory and modelling approaches for organizations, which have been called 'Mathematical/Computational Organization Theory'.¹ Computational and mathematical approaches are increasingly being turned towards solving organizational level problems, such as technology integration, organizational design, information systems design and management, telecommunications management, analysis and diagnosis of large-scale systems, etc.

To date, several scientific meetings dealing primarily with Mathematical and Computational Organization Theory issues have been held or are soon forthcoming. These include:

The Workshop on Artificial Intelligence and Organization Theory held at the Center for

¹ Similar movements have appeared in other fields including computational physics, computational biology and computational economics, to name a few.

Computer Science in Organization and Management at the University of Amsterdam, in Summer, 1990.

Three Mathematical Organization Theory Workshops held under the auspices of the Institute for Management Science (TIMS), with a fourth planned for the ORSA/TIMS' 94 meeting in Boston.

The American Association for Artificial Intelligence's Fall Symposium on Knowledge and Action in Social and Organizational Levels (KASOL) held in the fall of 1991 (Agre and Gasser, 1991).

The American Association for Artificial Intelligence's Spring Symposium on Computational Organization Design to be held in March 1994. Numerous workshops on Distributed Artificial Intelligence sponsored by AAAI and others, held since 1980 (Bond and Gasser, 1988).

From these workshops two books have appeared with strong contributions to Computational and Mathematical Models of Organizations (Carley and Prietula, 1994; Masuch and Warglien, 1992).

This special issue provides a collection of papers that focus on Computational and Mathematical Models of Organizations.

PAPERS IN THIS ISSUE

There are six papers in this issue spanning a wide range of research in a number of disciplines, including accounting, civil engineering, computer science, electrical engineering and sociology.

K. Decker and V. Lessor, in their paper 'Quantitative modeling of complex environments', present a framework that can be used to model complex computational task environments that is consistent with agent-centred and experimental approaches. The framework (TAEMS) provides both a language and a system for simulation.

N. Hummon, in 'Organizational structures and exchange processes', explores how social structures can be generated using exchange processes. A simulation is used to study how the exchange process generates division of labour and co-ordination networks.

Y. Jin's 'i-Agents: modeling organizational

problem solving in multi-agent teams' is a computerized framework for studying organizational problem solving in multi-agent teams. There are four high-level concepts used in the system: Organization; Agent; Task; and Communication. The system is used to investigate the issue of how a group of intelligent agents can be organized in ways that match the group with its task and environment in order to achieve effective and efficient organizational performance.

Z. Lin and K. Carley, in their paper 'Proactive or reactive: an analysis of the effect of agent style on organizational decision-making performance', address an issue of agent style using simulation. In particular, they investigate co-ordination issues associated with agent styles of proactive and reactive decision-making processes. They find that, on average, agent style does not matter, but it does for agents under time pressure.

A. Pete, D. Kleinman and K. Pattipati, in 'Tasks and organizations: a signal detection model of organizational decision making; present a mathematical model to study the joint impact of organizational design and of the task environment on decision performance of hierarchical organizations with limited internal communication. Structural properties are modelled using graph-theoretic formalisms. Expertise is also captured in the model. They show that there is no overall best organizational design and that performance of different designs is dependent on the structure of the task environment.

J. Yost, in his paper 'Costly communication and delegation in multiple division firms', develops a mathematical model of the costs and benefits of delegated decisions in a multi-division firm. Using the revelation principle, Yost finds that absent the costs of communication, the profitability of a centralized scheme weakly dominates the profitability of a delegated one.

SOME FURTHER RESEARCH TOPICS

One of the primary purposes of an issue like this is to generate additional research. Some topics could include:

- How does organization theory relate to AI and computational models of organizations?
- What level of sophistication of our models is required in order to generate realistic organizational results?
- What is the empirical behavior of AI-based computation and mathematical models of organizations?
- How should different types of agents be organized?
- How do AI-based computational models relate to human organizational models?
- What is the interaction between precise theories and models of organizational level phenomena and intelligent group or collaboration technologies?
- Under what conditions does the intelligence of organizations become greater than or less than the sum of the intelligence of its agents?

Some of these topics are addressed in the papers in this issue. However, there is much more room for exploration and development of these and other questions.

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