Notes on Organization Design from the Perspective of AI

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An AI-oriented approach to organization modeling, analysis, and design entails building specific, computational models of things that we often (informally) call "organizations". Such models will be formal in the sense that they are computational---that is, they will have some defined semantics in the sense that a computer will take specific actions when operating upon them in a design or analysis process [Gasser et al. 1993].

Presently, we seem to have a tradeoff between clearly, pragmatically and computationally defining the concept of "organization" on the one hand, and capturing the richness of features of interesting (e.g. complex, human) organizations on the other. The aim of this paper is to begin to think through the needs a computational theory of organization that is clear, rich, and representative, and yet still useful for both computational analysis and design.

Some well-known attempts to define organization in AI are direct, simple and mundane---these include approaches such as those used in the UMASS DVMT [Durfee et al. 1987] and our own OSD project [Ishida et al. 1992], in which "organization" is seen as a (reconfigurable) mapping of capabilities to "agents" (that is, functional specialization) coupled with a distribution of knowledge and control to exploit this specialization so as to minimize resource use, called "coordination" or "distributed, network-wide control." With this conceptual basis, organizational change is viewed as change in the mapping of capabilities to agents, coupled with a redistribution of knowledge about this mapping and its control consequences into the organizational coordination/control processes. An organizational change is triggered by a mechanism through which some organizational elements monitor and assess the organization's performance, and decide how and when to reconfigure.

The DVMT/OSD notions of organization entail several epistemological and ontological commitments toward what elements of organization are important, and in what ways they are important. These notions of organization don't explicitly capture, for example, notions such as social power or redefinition of meanings that are typical and important in human organizations (nor are they intended to). It is in these choices that richness and representational fidelity is enhanced or limited. However, the basic concepts with which the notions of "organization" are modeled and operationalized have tremendous impacts because they specifically direct the ability to reconfigure or design organizations--they determine what elements can be varied and in what ways they can vary.

Given this framework, we can begin to ask several sets of questions at a basic organization modeling level:

Basic modeling questions about organizations, when considering organizations from an *action-oriented* perspective:

What is the meaning of action and change in an organization? (E.g., what is transformed when action or change occurs, and how do we describe this at a large scale?) What is the unit (locus) of action? (e.g. what is doing the changing?) What is the role of units of action vis-a-vis one another? How are units of action composed across levels, into higher-order units of action? What is the "glue" that holds these compositional units of action together over time---i.e. that makes them into temporally-stable "units?"

Basic questions about organizations, when considering organizations from a *structure-oriented* perspective:

What are the elements of an organization that determine its "structure"? What is it that changes when an organization's "structure" changes? What about structure changes when an organization "learns"? Basic questions about organizations, when considering organizations from an information-oriented or "organizational-cognition" perspective:

Where is information "stored" in organization (e.g. in its structure? in its constituent units? how?). What would be the nature of "organizational memory"? What would it mean for an organization to "perceive" an environment or context? What are the interpretive processes of organization (as versus a participant), and where are these "located?" What would it mean for an organization (as versus a unit) to have a "goal"? How would organizational goals come about, change, and be achieved? (What is a teleological perspective on organization?)

The basic questions for computational organization design would seem to be along the lines of what are the productive or possible relationships between elements of these different perspectives and how can these be pragmatically exploited? For example:

What are the relationships between organization structure, organizational context or environment, "organizational goals," and possible/plausible actions? (I.e., give a theory of organizational action.)

How can knowledge of the useful and useless nature of these relationships be exploited so as to (dynamically re-) configure organizations for optimal performance, environmental fit, longevity, flexibility, etc.? (I.e., give an organization design process and resulting implemented designs).

Answering these organization design questions requires making choices (even implicit ones) on the more basic questions of how to select and represent (explicitly, computationally) key elements such as organization structure, action, change, cognition, etc. Especially in cases when we also need to account for composition, stability, distribution, scale, etc. we have very little presently to go on.

Computational Organization Design

In speaking of computational organization design, in this paper, we are concerned only with model-based design that is either partially or wholly supported by computer-based models of the designed artifact. This is in contrast, for example, with a participatory, action-oriented design process, in which an artifact emerges without a preconceived design by making design operations directly on the emerging artifact.

It is also in contrast to a self-design process in which a version of the artifact operates on itself without explicit models, and reconfigures itself reactively (non-reflectively) [Ishida et al. 92].

Model-based COD divorces organization design from implementation. Design is carried out by manipulating and evaluating a model, and later the model is implemented into an actual structure (which may, of course, lead to redesign). Model-Based COD is an exercise with three interactive and iterative stages. One stage is conceptual modeling: the selection of important modeling features and quality criteria, and deriving a model structure that represents a space of design possibilities, and populating that model structure with an artifact theory---a set of necessary relationships among model features. Another stage is refinement: ranking parts of the design space over others, effectively pruning the number of possibilities in the design space to converge on an accepted design. The third activity is assessment: a multi-dimensional (global) assessment of the desirability of the overall design, relative to the quality criteria.

The overall COD design process is one of continuous and repeated iteration over these stages, refining a design space down into a single point. The COD design process then comprises the following decisions, which require the indicated knowledge:

Conceptual Modeling Decisions:

Identifying key modeling dimensions and values. [Knowledge of appropriate design spaces]

Identifying the appropriate artifact theory relationships that express necessary interactions among design features. [Knowledge of artifact theory]

Refinement decisions:

Process (meta) decisions, including which design dimensions to refine in what order. [Knowledge of architecture of the design space]

Design feature decisions including which feature values to select to prune the design space. [Heuristic or algorithmic knowledge about the impacts of design choices.]

Assessment Decisions:

Identifying quality criteria (which may be simply additional modeling dimensions that have been selected as quality criteria). [Knowledge of which criteria form quality impacts]

Calculating global assessments of particular design subspaces. [Knowledge of quality measurement]

Exploration, alternative generation, and evaluation are intertwined in any design activity; each guides the other, and provides context for the other.

The USC/NCMS ACTION Project's COD system comprises all of these. Here we give some suggestive illustrations of just two:

ACTION's Conceptual Models of Organization:

Business Objectives

Process Variances

Information Resources
Tool, fixture, and materials Resources
Software Resources
Equipment Resources
Technical System Characteristics
Activities
Skills
Performance monitoring and reward characteristics
Production Contexts (workflows)
Customer Involvement Levels
Discretion Loci
Employee Values
Norms
Production Process Characteristics
Reporting Structure Characteristics

ACTION's COD Design Decisionmaking Knowledge:

1) Predictive structuring (ideal profiles) that are contingent on starting conditions (e.g. goals, process variances, and production contexts.) Backtracking here means undoing the predictions' effects, when the starting conditions change.

2) Constraint-based propagation of choices on evaluation criteria. backtracking here means undoing effects of constraint propagations.

3) Clustering of activities based on design heuristics. Backtracking here means unclustering activities by removing or augmenting heuristics.

CONCLUSION

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