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Editorial: the challenge of situated cognition for symbolic knowledge-based systems

Tim Menzies
NASA/WVU IVV Facility, 100 University Ave, Fairmont, West Virginia, USA 26505

William J. Clancey
Computational Sciences Division, NASA/Ames Research Center, Mail Stop 269-1, Moffett Field, CA 94035, USA. e-mail: bclancey@mail.arc.nasa.gov

What is situated cognition and what are its implications for the practice of building expert systems? This special issue has collected a range of papers that show situated cognition to be meaningful to the designers of human–computer systems, manifested by a variety of new modelling tools and methods. In this editorial, we offer some brief introductory remarks about situated cognition and the papers.

Situated cognition is an approach for understanding cognition that seeks to relate social, neural and psychological views (Clancey, 1997). Situated cognition explores a host of fundamental assumptions about artificial intelligence and the process of building expert systems. These considerations are much more complicated than the traditional symbolic view of knowledge and include the following.

- The social context of knowledge, e.g. decision making is grounded in organizational identity and norms.
- The structural aspects of human memory that allow for self-organization and reconstruction of ideas, e.g. behaviour may be conceptually coordinated without describing either the world or the behaviour.
- The manner in which previously articulated heuristics, designs and policies are reinterpreted in practice. Situated problem solving often involves the reconception of meanings and goals, especially in multidisciplinary pursuits. For example, the relation of medicine, economics, lifestyles and ethical policy in the practice of medicine.

Consequently, we cannot expect to write one symbolic model once and reuse it in all situations to come. Symbolic models, such as those found in expert systems, are *tools* that people can use, not the mechanism by which human perception, conception and action are actually coordinated in the brain. When a model is used by people in a new situation, their (situated) cognition forces adaptations to that model. These adaptations may be either implicit conceptual changes or explicit interpretative changes. More generally, situated cognition research says that human judgment involves the following.

- Re-conceiving what words mean and how ideas relate.
- Not just making logically correct inferences over a set of descriptions about the world and how to behave.

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An extreme response to the challenge of situated cognition is to:

- reject the symbolic, knowledge-based systems (KBS) paradigm (e.g. for a connectionist approach) in building intelligent robots; or …
- abandon the whole idea of building "expert systems".

This special issue explores if there is an alternative to this extreme response. Can we use symbolic modelling techniques to build useful tools for people? It may be true that we cannot capture knowledge as universally applicable theories and their interpretations. However, the following are some of the concerns explored by the papers in this issue.

- Can we usefully view a KBS as an assistant?
- Can a KBS ever be surrogate for a human being? If so, what changes (if any) does this imply for symbolic KBS architectures and the process of building, using and maintaining symbolic models?
- Does situated cognition suggest new kinds of applications for KBS methods?

All the papers explore new methods for building, using and evaluating descriptive models of knowledge.

Overview of the papers

Traditional expert systems, based on the idea that operational knowledge has a fixed, form, can be of value in certain circumstances (at least for novices). However, rarely is operational knowledge static. Real institutions are in a constant state of flux. Workers in an area must continually learn new models or re-interpret old models. These workers are deemed competent in that environment when they can demonstrate to their community that they can exhibit knowledge and skills about many issues, including the current social norms; values and rules; corporate politics; and technology basis.

In our first paper by Kahn, Mitchell, Brown and Leitch, such situated learning is characterized as the collaborative exploration of multiple descriptive models representing different viewpoints. Like Schön (1983), Kahn *et al*., argue that the re-framing of old knowledge to create some new viewpoint is part of creative problem solving. The paper by Kahn *et al*. is an appropriate prelude to our next two papers.

- In our second paper, O'Neill explores in detail the re-framing using an extensive case study (a humanitarian disaster relief after volcanic eruptions at Rabaul in 1994). After detailing the case study, general principles are given for re-framing (as implemented in his Framer system).
- The Kahn paper in particular, and the situated cognition research in general, argues that the activities of an intelligent agent influences how an agent interprets and re-interprets information. Our third paper by Clancey, Sachs, Sierhuis, and Van Hoof describe Brahms, a tool for modelling agent activities. Brahms is a tool for modelling work practices of groups, on concepts and observational methods from the social sciences, in particular anthropology. In Brahms, workflows are not pre-ordained, rigid protocols that all agents must follow. Instead, a Brahms workflow is an emergent product of how agents locally interact with each other (e.g. via fax machines, computer terminals, phones) and the representational artifacts (e.g. faxes, databases, voice mail). This emergent approach to specifying workflows is a natural tool for modelling shifting patterns of activities.

Standard knowledge acquisition is very focused on the task of a system and the ontological assumptions made by that task. Assuming the situated stance means changing the process of knowledge acquisition; for example:

- The reasoning and representation primitives of Framer are different to standard knowledge acquisition.
- In Brahms, tasks are contextually described in terms of activities by which agents chunk their work day (e.g. such as reading email).

More generally, our fourth article by Menzies explores how a situated knowledge acquisition approach would differ from standard knowledge acquisition. An open problem for standard knowledge acquisition is how to continually re-interpret an existing system when the situation changes. Menzies explores the severity of this problem and then offers a sketch of the general form of an alternate, situated knowledge acquisition, program:

- Modelling the environment of a knowledge-based system.
- Knowledge engineering metrics.
- Representation options which enable the continual testing of theories.
- An emphasis of maintenance rather than design.

Our fifth paper by Richards and Compton is a system that almost totally focuses on maintenance. In a ripple-down-rule system, there is very little emphasis on initial modelling. Instead, a fledging system is quickly dropped into a maintenance environment where the context of the latest error is used to guide revisions to the knowledge base. If a model of the system is required, Richards and Compton show how to automatically generate concept hierarchies from the ripple-down-rule system. This approach has been shown to be a cost-effective way of building expert systems, suggesting that a situated maintenance approach might out-perform current "get it right the first time" design-focused approaches.

Our last paper by Rappaport is a short commentary on other implications of situated cognition research about standard knowledge acquisition practice. Rappaport discusses neurological evidence for situatedness and argues for the development of hybrid architectures for expert systems (a combination of connectionist and symbolic knowledge-based systems).

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