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Editorial

Introduction to the special issue on computational cognitive modeling

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Abstract

This special issue of Cognitive Systems Research features the top twelve papers from the 4th International Conference on Cognitive Modeling (ICCM-2001). These papers represent the current trends in computational cognitive modeling, displaying both the diversity and commonalities of the field. This introduction to the special issue describes the motivations for the conference and the special issue, and overviews the diversity and commonalities found in the papers.

There are many forms of modeling that serve an important role in cognitive science. AI models speak to the difficulty of the task being approached and the nature of computations that effectively solve the task. Verbal frameworks, often called models in psychology, describe a set of mechanisms at an abstract level without prematurely committing to specifics (Lovett & Schunn, 2000). Mathematical models provide concise closed-form descriptions of regularities in data. By contrast, computational models provide mechanistic explanations and the means for testing the sufficiency of those explanations.

In recent years, the popularity of the computational cognitive modeling approach has grown to become a central but sometimes fractionated theme in research on cognition. The centrality of the computational approach to cognition is suggested by two facts. First, computational cognitive modeling is not an isolated enterprise limited to its own world of specialist conferences and journals. Although specialist conferences do exist, work in computational cognitive modeling is presented at core cognitive conferences and published in mainstream cognitive journals. Second, it is now possible to publish purely computational work in experimental psychology journals (e.g., Ellis & Ralph, 2000; Farrell & Lewandowsky, 2000). This unheralded breakthrough suggests that experimentalists have begun to value modeling in its own right rather than simply tolerating it as an addendum to experimental work.

Despite its increasing centrality, the modeling world seems fractionated. Our general face is divided between meetings that are either too general (such as

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the annual Cognitive Science conference) or too specific (such as the annual neural nets, ACT-R, and Soar meetings) to address issues that transcend modeling approaches. Such issues include statistics and methodologies for testing and validating computational cognitive models, detailed comparisons of different approaches, as well as understanding the contribution that different approaches can make to understanding the same phenomena. It was to fill this void that the International Conferences on Cognitive Modeling (ICCM) came into being.

The 4th ICCM, ICCM-2001 took place at George Mason University in late July of 2001 (see http://hfac.gmu.edu/~iccm).[1] The Newell Award for best student paper was awarded to Michael Fleetwood for his paper with Michael Byrne, *Modeling Icon Search in ACT-R/PM.* Dario Salvucci and Kristan Macuga won the Siegel-Wolf Award for the best applied research paper. (Both of these papers are included in this special issue.) During the Doctoral Consortium meeting the day prior to the conference, seven doctoral students from universities around the world met with three faculty researchers. The Doctoral Consortium provided an opportunity for the students to meet their peers and mentors and to explore their dissertation work in an intense but friendly, multi-approach environment. The work presented at the Doctoral Consortium was also presented during the ICCM-2001 poster session and is documented in the proceedings. The next ICCM is expected to be in Bamberg, Germany in the Spring of 2003.

Arthur Markman opened ICCM-2001 with a plenary talk. The birth of new modeling approaches seems accompanied by hyperinflated claims for the new approach and against the old approaches. In recent years, Markman and his colleague Eric Dietrich have done much to put in perspective the complementary strengths and weaknesses of extant modeling approaches (e.g., Markman, 1999; Markman & Dietrich, 2000a,b). Markman's focus on knowledge representation as a common denominator in all modeling approaches became a central theme in formal and informal discussions held throughout ICCM-2001.

The 35 papers presented at ICCM-2001 were diverse along many dimensions. Talks by 22 established researchers were interspersed with talks by 13 of the next generation of researchers. The disciplines contributing to ICCM-2001 were likewise diverse. Psychology had the largest representation with 14 papers. The next largest group was 13 papers from the hybrid disciplines of Cognitive Science, Artificial Intelligence, Human-Computer Interaction, and Informatics. Our tally of disciplines is completed by Computer Science (4), industry and government laboratories (3), and Industrial Engineering (1). ICCM-2001 was geographically diverse as well. As might be expected, the host country provided the largest single contingent with 20 papers from the United States. Fourteen papers were from Europe (5 UK, 2 from each of Germany, Portugal and The Netherlands; 1 from each of Italy, Bulgaria and Sweden) and one was from Japan.

Despite the stimulating effects of diversity in experience, discipline and geography, the most important goal for ICCM-2001 was diversity in approaches to modeling cognitive data. ICCM scored high on this measure as well. The largest block of papers (10) was in the neural net tradition. The next largest (9) used the hybrid architecture of ACT-R (Anderson & Lebiere, 1998). Pure symbol system architectures were represented by CHREST (Gobet & Simon, 2000), inC (Guhe & Habel, 2001), Soar (Newell, 1990) and CogNet (Zachary, Ryder & Hicinbothom, 1998) (7 papers). The conference also included two applications to modeling of machine learning techniques, three mathematical modeling or Bayesian modeling papers, and four papers that focused on issues that cut across modeling approaches.

The 12 papers chosen for this special issue of *Cognitive Systems Research* reflect the emerging commonalities in the field of computational cognitive modeling as well as the diversity of approaches found at ICCM-2001. In selecting this dozen we were guided by a number of criteria. First, we used the ratings and comments provided by the original reviewers of ICCM-2001 submissions. Authors had

[1] While the 2001 meeting was called the 4th ICCM, in fact the first two meetings did not use the ICCM title. The first meeting, in 1996, was called the European Workshop on Cognitive Modeling. The second meeting, in 1998, was called the European Conference on Cognitive Modeling. The third meeting, held at Groningen in The Netherlands in 2000, was the first to be called an International Conference on Cognitive Modeling.

submitted full papers to the conference, and several reviewers carefully reviewed each submission. Second, for each member of the set of highly rated papers, we used our knowledge of the differences between the paper submitted and the paper published to judge how responsive the authors had been to reviewer comments. Finally, our experience as attendees of ICCM-2001 allowed us to use the excitement generated by the talk as a gauge of the work's importance.

The results of this selection process are 12 papers that illustrate the diversity of computational cognitive modeling. Some of the papers focus on frequently-modeled phenomena, whereas others focus on phenomena modeled for the first time. Some of the models used results from neurobiology to constrain their implementation details, whereas others remain purely at Marr's (1982) computational level. Some of the models were built within general cognitive architectures (e.g., ACT-R), whereas other models were built within a framework developed for a more narrow range of phenomena. Finally, some of the models were developed from a pure research perspective, whereas other models were developed to solve applied problems.

What bind these diverse papers together are two features that reflect the core principles of computational cognitive modeling. First, these papers go beyond verbal or mathematical descriptions of theories or phenomena to provide mechanistic accounts that can produce the phenomena being explained. Second, the papers pay serious attention to details of the empirical data. What differentiates computational cognitive modeling from AI approaches and verbal models is our attempt to reproduce the behavioral consequences of cognitive processes in as great a detail as possible.

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References

Anderson, J. R., & Lebiere, C. (Eds.) (1998). *Atomic components of thought*. Mahwah, NJ: Erlbaum.

Ellis, A. W., & Ralph, M. A. L. (2000). Age of acquisition effects in adult lexical processing reflect loss of plasticity in maturing systems: Insights from connectionist networks. *Journal of Experimental Psychology-Learning Memory and Cognition*, *26*(5), 1103–1123.

Farrell, S., & Lewandowsky, S. (2000). A connectionist model of complacency and adaptive recovery under automation. *Journal of Experimental Psychology-Learning Memory and Cognition*, *26*(2), 395–410.

Gobet, F., & Simon, H. A. (2000). Five seconds or sixty? Presentation time in expert memory. *Cognitive Science*, *24*(4), 651–682.

Guhe, M., & Habel, C. (2001). The influence of resource parameters on incremental conceptualization. In Altmann, E. M., Cleeremans, A., Schunn, C. D., & Gray, W. D. (Eds.), *Fourth International Conference on Cognitive Modeling* (pp. 103–108). Mahwah, NJ: Erlbaum.

Lovett, M. C., & Schunn, C. D. (2000). The importance of frameworks for directing empirical questions: Reply to Goodie and Fantino (2000). *Journal of Experimental Psychology: General*, *129*(4), 453–456.

Markman, A. B. (1999). *Knowledge representation*: Mahwah, NJ: Erlbaum.

Markman, A. B., & Dietrich, E. (2000a). Extending the classical view of representation. *Trends in Cognitive Sciences*, *4*(12), 470–475.

Markman, A. B., & Dietrich, E. (2000b). In defense of representation. *Cognitive Psychology*, *40*(2), 138–171.

Marr, D. (1982). *Vision*. San Francisco: W. H. Freeman.

Newell, A. (1990). *Unified theories of cognition*. Cambridge, MA: Harvard University Press.

Zachary, W. W., Ryder, J. M., & Hicinbothom, J. H. (1998). Cognitive task analysis and modeling of decision making in complex environments. In Cannon-Bowers, J. A., & Salas, E. (Eds.), *Making decisions under stress: Implications for individual and team training* (pp. 315–344). Washington, DC: American Psychological Association.