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On the Computational Complexity of Analogy-Based Models of Problem Solving Implications and Opportunities

By

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In addition to being an object of study in its own right, the process of deriving the best possible analogy between two situations or concepts is also of use in general problem solving. For example, given a set of pairs of problem-instances and problem-solving strategies that proved useful in in the past in solving each of these instances, one way of selecting an appropriate strategy for a new instance is to find the stored instance that is most analogous (and hence relevantly similar) to the new instance and then employ that stored situation's strategy. If this strategy in turn is phrased in terms of roles or slots that are filled by particular aspects of the stored instance, e.g., move(X, Y) where X and Y are entities in instance I, the derived analogy is also useful in establishing the corresponding aspects of the new instance. The fact that deriving analogies is computationally difficult (i.e., NP-hard) in general has motivated the use of heuristics in both AI systems for and cognitive theories of problem solving. However, it may yet be feasible to derive analogies optimally in the restricted problem-solving situations encountered by human beings in everyday life, rendering these heuristics unnecessary.

In this talk, I will summarize known computational complexity results for both analogy derivation and other analogy-based processes such as solution adaptation, example retrieval, and example generalization that occur within various models of analogy-based problem solving. The models examined use the popular structure-mapping framework for analogy derivation proposed in Gentner (1983), which has been implemented in a number of AI systems, i.e., SME, MAC/FAC, SEQL, Companions.

The implications of these complexity results for both practical AI systems and cognitive theories of problem solving will also be discussed. (This work has been done in collaboration with Patricia Evans (UNB Fredericton), Jason Gedge (University of Alberta), Moritz Muller (Albert-Ludwigs-Universitat Freiburg, Germany), and Iris van Rooij (Radboud University Nijmegen))

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Dr. Todd Wareham is an associate professor in Computer Science at Memorial University of Newfoundland. He received his PhD in Computer Sciencefrom the University of Victoria in 1999, and has been a faculty member at MUN since 1999.

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