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Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 19(0)

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Publication Date
1997

Peer reviewed

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Introduction

Multiple instantiation involves the simultaneous use of the same parts of the knowledge base in different ways. Knowing that "John is in love with Rita" and that "Rita is in love with John", you can easily infer that they should be happy. To arrive at that conclusion you had to instantiate the predicate "is in love with" and the objects "John" and "Rita" twice. Models that load copies of pieces of knowledge into a working area before transforming them do not have any problem with multiple instantiation. They simply make several copies of the same content. However, for connectionists models that use the structure of the knowledge base itself as the place where concepts are associated, transformed and where inferences are drawn, multiple instantiation is a serious problem. Based on Shastri & Ajjanagadde (1993) SHRUTI model, INFERNET, implements a working memory that is the activated part of long term memory. This is achieved by making use of temporal properties of the node spikes, namely, synchrony and rythmicity. A particular solution of the problem of multiple instantiation is proposed. This model makes predictions that have been tested experimentally and the results of these experiments are reported here.

Multiple instantiation

While SHRUTI uses a set of copies of the predicate and its argument slots, INFERNET modifies oscillation frequency to enable multiple instantiation. This means that nodes pertaining to a doubly instantiated concept will oscillate twice as fast as singly instantiated ones. If we assume an oscillation frequency between 30 and 100 Hz., *the number of multiple instantiation should be limited to around 3, with little or no additional cost to the system.* Our model also suggests that people deal with more instantiations by replacing several windows of synchrony by a single "chunked" one. If the number of instantiations exceeds 3, there will be an increase in processing time and this increase will be proportional to the difficulty of "chunking." Sougné (1996), Experiment 2, provides empirical evidence for that process. In INFERNET a concept is represented by a set of nodes firing in synchrony. The distributed nature of each concept implies that closely related concepts have a number of nodes in common. If, in a reasoning episode, two related concepts are needed and if they cannot belong to the same window of synchrony, the nodes that they share must be instantiated twice. In the present experiment the number of closely related concepts was manipulated.

The 40 participants were randomly assigned to each of two conditions. These two conditions differed in the amount that the concepts used in the experiment shared common properties. Two rules of the type $A \supset B$ (material implication), one for each condition, were constructed. The rules have the same length. The first rule involved rather distant concepts; the second rule used more closely related concepts. Four questions for each condition were used.

There was a highly significant difference of mean reaction time (Unpaired Student t $(35) = 3.432$ $p < .005$) for answering the first question presented. All other differences of reaction time were not significant.

There is no difference for subjects reading one rule or another, but when they receive the first question, they must encode the rule in a particular way permitting the inference to be drawn. This encoding requires dealing with multiply instantiated properties that share the concepts used in the rules. A replacement process is required. When the next questions appears, this replacement has already been made, and the reaction times no longer differ. There is no significant difference between the two groups for each of the question types A, ~A, B and ~B nor for the conclusions inferred.

These results would seem to support distributed concept representations and challenge modular accounts of memory. For these models (e.g. Baddeley, 1986), Working Memory is separated from Long Term Memory and parts of LTM are loaded into WM when needed. According to these models, multiple instantiation will not increase reaction time. The results reported here contradict this prediction.

Acknowledgments

This research was supported by the Belgian FNRS Grant D.4516.93 & PAI Grant No. P4/19. Thanks to Robert French.

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