Statement of Interest

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Our research group at the University of Maryland is working on a project involving the exploration of massively parallel implementations of fully symbolic semantic network-like representations. Our system (called PARKA) runs on a Connection Machine (CM) and exhibits very promising gains in time-performance over our serial (Common Lisp) version. We have also been very concerned with the semantic foundations and expressive power of the PARKA language. To this end we have explicated the meaning of PARKA representations in the context of previous work on term subsumption languages and the philosophy of language. We have also provided a powerful collection of knowledge representation mechanisms so that PARKA will be a useful knowledge representation tool for future AI work. For example, we provide a mechanism for multiple inheritance based on the work of Touretzky [1], and a new mechanism for the representation of part/whole relations.

PARKA’s CM implementation uses the CM’s SIMD architecture and “activation wave propagation” algorithms to achieve impressive speed characteristics. Although the CM version does not yet have the full PARKA semantics, our initial implementation has been tested and timed extensively with very large (up to 16000 nodes) randomly generated nets. The results show that we can expect exponential time savings for many kinds of queries including simple property inheritance. Queries which would normally require an amount of time proportional to the number of nodes in the network will often require
only an amount of time proportional to the DEPTH of the network in the CM version. Since AI hierarchies are often wide and shallow this can present tremendous savings. Our test queries on relatively shallow but very large hierarchies (less than 20 levels) executed in less than 1 second, and much of that time can be attributed to the (constant) overhead of communications between the CM and its host. A complete description of these experiments and an analysis of the resulting data is available separately [2].

The constraint of efficient CM implementation influenced the development of PARKA's semantics in interesting ways. For example, PARKA's requirements for explicitness of representation lead us to experiment with "topology constraints" (which are maintained at update time) in order to capture the functionality provided by implicit or procedural knowledge in other systems. Our mechanisms for the specification of "definitional" values and for the specification of restrictions on category values both rely on checks at update time so that queries can take full advantage of the parallel algorithms. Other powerful update procedures allow the use of representations which have previously been accomplished with procedural attachment. For example, we have mechanisms which create set-theoretically defined categories which maintain their integrity across updates, and a mechanism which manipulates the isa hierarchy to ensure that the proper transitivities between "isa" relations and part/whole relations are always represented explicitly. (Our work of part/whole relations draws from work Cognitive Science work in [3].)

With regard to its semantic foundations, we say that PARKA represents the references of category and individual terms by specifying descriptions of the category members and individuals to which such terms apply. Our thinking in this area has been strongly influenced by Kripke [4], and we have discussed elsewhere the relation between "description" and "reference" and the implications of these ideas for knowledge representation [5]. Here we will note only that our notion of a "category" differs markedly from that of a "set", "class", or KL-ONE "Generic Concept". PARKA descriptions are in general NEITHER necessary NOR sufficient conditions for category membership (although there are exceptions to this rule). Although previous systems have been criticized for having exactly this "problem", we feel that our approach is both philosophically justified and, within the proper semantic context, of practical utility. Set-theoretic and classificatory concerns are, in PARKA, of secondary importance to the specification of the REFERENCE
of the TERMS which name the structures.

We wish to participate in the Term Subsumption Languages workshop in order to discuss this and related work with other researchers in the field. Our work spans several of the areas mentioned in the Call for Participation, and we can contribute to discussions ranging from philosophical foundations to details of parallel implementation. Papers [2] and [5] are available on request.

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