Marker-Passing on a Parallel Knowledge Processing Testbed †

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Abstract

We have been experimenting with knowledge representation and reasoning mechanisms suitable for parallel computation. Our primary domain is Natural Language Understanding (NLU) using a semantic network representation and parallel marker-passing techniques. We have implemented a multiprocessor called the Semantic Network Array Processor (SNAP-1) for real-time processing of moderately-sized knowledge bases.

1 Project Overview

We have designed a computer architecture which fits the processing requirements NLU, Knowledge Classification, Property Inheritance, and other knowledge processing applications. Our research objectives include:

- perform limited-domain text understanding and speech-to-speech dialog translation within seconds or milliseconds,
- investigate classification-based parsing of natural language,
- develop an automated knowledge acquisition capability using parallel classification techniques,
- study the performance of parallel marker-passing architectures.

2 SNAP-1 Testbed

A multiprocessor prototype of our architecture has been implemented and is operational at the Univ. of Southern California [1]. The SNAP-1 prototype consists of 144 processors grouped into 32 clusters of four to five processors each. Processors within clusters share a multi-ported marker-passing memory while communication between clusters is provided by a modified hypercube interconnection network. The parsing of sentences is performed by Direct Memory Access Parsing (DMAP) approach which relies on the propagation of flags called *markers* through the semantic network [2].

As shown in Figure 1, the hardware environment consists of a SUN *host* which provides the user interface, an *array* of 144 processors to store and process the semantic network, and a *controller* which manages the array. The semantic network is stored as a distributed knowledge base and marker-passing is performed locally where the knowledge is stored.

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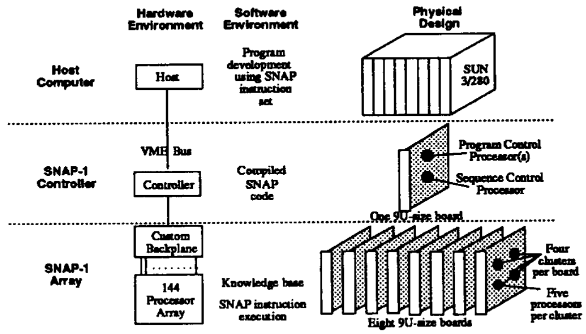

Figure 1: SNAP-1 system.

3 Knowledge Representation

The knowledge representation scheme includes generic and individual concepts (graph nodes), user-definable relations (graph links), and markers (flags at each node). Each marker contains set-inclusion bits, a floating-point value, a propagation rule, a propagation logical/arithmetic operation, and a timestamp. Propagation rules govern how markers are passed. They have the format of *Rule, R1, R2* where *Relation1* and *Relation2* are the relations that rule affects. For example, propagation rules include:

1. *SEQ(R1, R2)*: propagate through R1 once, then R2 once,
2. *SPREAD(R1, R2)*: for each node along an R1 path, switch to R2 link and continue propagation,
3. *COMB(R1, R2)*: all R1,R2 links without limitation,
4. *END-SPREAD(R1, R2)*: same as SPREAD except marks only last node,
5. *END-COMB(R1, R2)*: same as COMB except marks only last node.

References

[1] R. F. DeMara and D. I. Moldovan, "The SNAP-1 Parallel AI Prototype," in *Proceedings of Eighteenth Annual International Symposium on Computer Architecture*, 1991.

[2] H. Kitano, "DM-Dialog: An Experimental Speech-to-Speech Dialog Translation System," *IEEE Computer* **24**(6), pps. 36-50, June 1991.

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