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REPRESENTING NUMBERS IN SEMANTIC NETWORKS: PROLEGOMENA

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Introduction

We are studying various methods of representing numbers in semantic networks. There are two reasons for this. First, semantic networks have been proposed since the late sixties as formalisms for the general representation of knowledge. Lately, their popularity has increased. Yet problem areas persist for which the representations have not yet been carefully worked out. Some of these are discussed in Woods, 1975. Numeric information is another of the issues that "need to be addressed and solutions integrated into a consistent whole in order to produce a logically adequate semantic network formalism" (Woods, 1975, p. 80).

The second reason for the interest in representing numeric information is that reflection on this problem, and experimentation with various alternatives have led to the conclusion that numeric information is basically syntactic rather than semantic. This conclusion suggests that the way to provide numeric information to a semantic network is to provide it with a gracious interface to a syntactic representation - say a syntactic network. Moreover, such a dual network representation seems generally useful for natural language understanding systems.

This note sets the stage for an explication of semantic and syntactic networks, their differences, and possible interfaces between them. A more complete discussion is in preparation. Numeric information provides an example domain for the study.

Semantic Networks

Nodes of semantic networks generally represent unique concepts. An arc of a semantic network represents a relationship between two concepts that itself is not a concept. For many examples of such relations see Bruce, 1975.

In pictorial representations of semantic networks it is common to draw a node as a labelled circle. The label is a token of a three-way ambiguous symbol: a mnemonic device to help the drawer of the picture communicate with the reader of the picture; an identifier in the programmed implementation of the network that accesses the data structure representing the same node as the circle represents; an identifier of a node of the network considered as an abstract data structure (a kind of graph). We will refer to these three-way ambiguous symbols as *identifiers*. We might use the identifier 521 for the node representing the number variously written as "521", "DXXI", "five hundred twenty-one", etc. In an implementation of a semantic network, we might be able to convert the identifiers 521 and 26, to integer data types and compute the fact that 521 is numerically greater than 26, but information derived in such a manner is not being derived from the semantic network and is based on knowledge not represented in the semantic network.

Such knowledge can be represented in a semantic network by representing the concept of greater-than as a node, storing some greater-than facts explicitly, and storing rules for recursively deriving implicit greater-than facts from explicit ones using formalisms such as those described in Shapiro, 1977.

Syntactic Networks

A syntactic network has nodes representing such things as lexemes, clauses, and syntactic classes and arcs representing such relations as linear order in the surface string, membership in a constituent phrase, and dependency of a constituent on its governor. An example of a syntactic network is the chart of Kay, 1973.

We might determine that 521 is greater than 26 by noting that the numeral *521* has more digits than the numeral *26*. That this is a syntactic technique may be noted by realizing that it does not work for *DXXI* vs. *XXVI*. A syntactic network could be used to represent a numeral as a kind of clause consisting of a linear string of its digits.

Interface

An inter-network arc could be introduced between a semantic node and the highest level syntactic node representing the expression of the concept in some natural language. The LEX arc of Shapiro, 1975 serves such a purpose.

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