Commonsense Knowledge Representation II

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INTRODUCTION

Early attempts to implement systems that understand commonsense knowledge did so for very restricted domains. For example, the Planes system [Waltz, 1978] knew real world facts about a fleet of airplanes and could answer questions about them put to it in English. It had, however, no behaviors, could not interpret the facts, draw inferences from them or solve problems, other than those that have to do with understanding the questions. At the other extreme, SHRDLU (Winograd, 1973) understood situations in its domain of discourse (which it perceived visually), accepted commands in natural language to perform behaviors in that domain and solved problems arising in execution of the commands; all these capabilities were restricted, however, to SHRDLU's artificial world of colored toy blocks. Thus, in implemented systems it appears that there may be a trade off between the degree of realism of the domain and the number of capabilities that can be implemented.

In the frames versus logic debate (see Commonsense Knowledge Representation I - Formalisms in this Encyclopedia), the real problem, in Israel's (1983) opinion, is not the representation formalism itself, but rather that the facts of the commonsense world have not been formulated, and this is more critical than choice of a particular formalism. A notable attempt to formulate the "facts of the commonsense world" is that of **Hayes** [1978a, 1978b, 1979] under the heading of **naïve physics**. This work employs **first-order predicate calculus** to represent commonsense knowledge of the everyday physical world. The author of this survey has undertaken a similar effort with respect to **commonsense business knowledge** (**Ein-Dor and Ginzberg** 1989). Some broader attempts to formulate commonsense knowledge bases are cited in the section Commonsense Knowledge Bases.

COMMONSENSE AND EXPERT SYSTEMS

The perception that **expert systems** are not currently sufficient for **commonsense representation** is strengthened by the conscious avoidance in that field of commonsense problems. An excellent example is the following maxim for expert system construction:

Focus on a narrow specialty area that does not involve a lot of commonsense knowledge. ... to build a system with expertise in several domains is extremely difficult, since this is likely to involve different paradigms and formalisms. (Buchanan et al., 1983)

In this sense, much of the practical work on expert systems has deviated from the tradition in Artificial Intelligence research of striving for **generality**, an effort well exemplified by the General Problem Solver (Ernst and Newell, 1969) and by work in **natural language processing**. Common sense research, on the other hand, seems to fit squarely into the AI tradition for, to the attributes of common sense (Commonsense Knowledge Representation I), it is necessary to add one more implicit attribute, namely the ability to apply any commonsense knowledge in ANY relevant domain. This need for generality appears to be one of the greatest difficulties in representing common sense.

Consider, for example, commonsense information about measurement; knowledge of appropriate measures, conversions between them, and the duration of their applicability are necessary in fields as diverse as medicine, business, and physics. However, each expert system represents knowledge, including the necessary knowledge about measuring scales, in the manner most convenient for its specific purposes. No such representation is likely to be very useful in any other system in the same domain, and certainly not for systems in other domains. Thus, it appears that the reason for the inability of expert systems as currently developed to represent general purpose common sense is primarily a function of the **generality** of commonsense versus the **specificity** of expert systems.

From a positive point of view, one of the major aims of commonsense systems must be to represent knowledge in such a way that it can be useful in any domain; i.e. when storage strategies cannot be based on prior information about the uses to which the knowledge will be put.

This, then, is the major difference between expert systems and commonsense systems; while the former deal mainly with the particular knowledge and behaviors of a strictly bounded activity, common sense must deal with all areas of knowledge and behavior not specifically claimed by a body of experts. An expert system that knows about internal medicine does not know about skin diseases or toxicology and certainly not about drilling rigs or coal mining. Common sense systems, on the other hand, should know about colds and headaches and cars and the weather and supermarkets and restaurants and "chalk and cheese and sealing wax and cabbages and kings" (Carroll, 1872).

COMMONSENSE KNOWLEDGE BASE IMPLEMENTATIONS

Given the importance of commonsense knowledge, and because such knowledge is necessary for a wide range of applications, a number of efforts have been made to construct universally applicable commonsense knowledge bases. Three of the most prominent are Cyc, ConceptNet, and WordNet.

Cyc

The **Cyc** project (**Lenat** et al. 1990; Lenat, 2006) was initiated in 1984 by **Douglas Lenat** who has been at its head ever since. The objective of the project was to build a knowledge base of all the commonsense knowledge necessary to understand the set of articles in an encyclopedia. As of 2005, the **knowledge base** contained about 15,000 predicates, 300,000 concepts, and 3,200,000 assertions – facts, rules of thumb and heuristics for reasoning about everyday objects and events. The project is still active and the knowledge base continues to grow.

The formalism employed in Cyc is the **predicate calculus** and assertions are entered manually. (Cycorp, 2007). OpenCyc, a freely available version of Cyc may be downloaded from http://www.opencyc.org/.

ConceptNet

ConceptNet (**Liu and Singh,** 2004) is a commonsense knowledge base and natural-language-processing toolkit that supports many practical textual-reasoning tasks. Rather than assertions being registered manually as in Cyc, in ConceptNet they are generated automatically from 700,000 sentences of the **Open Mind Common Sense Project** (**Singh,** 2002) provided by over 14,000 authors., There is a concise version with 200,000 assertions and a full version of 1.6 million assertions. ConceptNet is constructed as a **semantic net**. A freely available version of the system may be downloaded at http://web.media.mit.edu/~hugo/conceptnet/#download.

WordNet

WordNet (**Felbaum,** 1998) is described as follows (WordNet, 2007): "Nouns, verbs, adjectives and adverbs are grouped into sets of cognitive synonyms (**synsets**), each expressing a distinct concept. Synsets are interlinked by means of conceptual-semantic and lexical relations. The resulting network of meaningfully related words and concepts can be navigated with the browser. … WordNet's structure makes it a useful tool for computational linguistics and natural language processing."

WordNet contains about 155,000 words, 118,000 synsets, and 207,000 word-sense pairs.

WordNet is available for free download at http://wordnet.princeton.edu/obtain.

FUTURE TRENDS AND CONCLUSION

Any system designed to process natural language must contain commonsense knowledge as do many other types of systems. Thus, the development of commonsense knowledge bases is sure to continue.

As a complete commonsense knowledge base must contain very large quantities of knowledge, the development of such a base is a very lengthy process that must be cumulative if it is to achieve its goal. Thus, commonsense knowledge base implementations will expand and improve over a lengthy period of time.