CS324: AI (Semantic Networks) **Spring 2015**

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12.1 Introduction

Owing to their more human-centered origins, the network-based systems were often considered more appealing and more effective from a practical viewpoint than the logical systems.

12.2 Semantic Networks

A network based representation provides means of structuring and exhibiting the structure of knowledge. In a network, the pieces of knowledge are clustered together into coherent semantic groups. It provide a natural way of mapping knowledge between the natural language and these networks. In addition, the network representation provide a pictorial representation of knowledge objects, their attributes and relationship between them.

The basic difference between ontologies we studied earlier and the semantic networks is, that ontologies are hierarchies, which may have multiple inheritance, providing knowledge organization of world. While, semantic networks follow the lattice structure for knowledge representation.

Semantic networks not only represent information but facilitate the retrieval of relevant facts. For instance, all the facts about an object "Rajan" are stored with a pointer directly to one node representing Rajan.

The Semantic networks have been used for knowledge representation in various applications like, natural language understanding, information retrieval, deductive data bases, learning systems, computer visions, and speech generation systems.

12.2.1 Syntax and Semantics of Semantics Networks

We can define a Semantic Network by specifying its fundamental components:

1. *Lexical part:* Nodes, Links, Labels
2. *Structural part:* links, nodes form directed graphs, and the labels are placed on the links and nodes.
3. *Semantic part:* Meanings are associated with the link and node labels
4. *Procedural part:* The *constructors* allow creation of new links and nodes, the *destructors* allow the deletion of links and nodes.

The word-symbols used for the representation are those which represent object constants and n-ary relation constants. The network nodes usually represent nouns (objects) and the arcs represent the relation between objects. The direction of arrow is taken from the first to the second objects, as they represent in the relations. In set-theory terms, *is-a* corresponds to the *sub-set* relation '$\subseteq$', and an *instance* corresponds to the membership relation '$\in$'(an object class relation). The commonly used relations are: *Member-of*, *Subset-of*, *ako* (a-kind of), *has-parts*, *instance-of*, *agent*, *attributes*, *shaped-like*, etc. The 'is-a'relationship occurs quite often, like, in sentences: "Rajan is a Professor", "Bill is a student", "cat is a pet animal".

The property inherited in semantic networks recognized as *default reasoning*. It is assumed that unless there is an information to contradictory, it is reasonable to inherit the information from the ancestor nodes. In figure 12.1, Pigeon inherits the property of "can fly" from the vertebrates, while Ostrich has locally installed attribute of "cannot fly", hence the property 'fly' will not be inherited by it.

12.2.2 Human Knowledge Creation

The semantic networks are based on the *associationist* theory, which defines the meaning of an object in terms of a network of associations with other objects. When human perceives and reasons about an object, that perception is first mapped into a concept. This concept is part of our entire knowledge about the world and is connected through appropriate relationships to other concepts. These relationships form an understanding of the properties and behavior of objects such as *snow*. For example, through associations we associate the snow with other concepts like, cold, white, snowman, slippery, and ice. Our understanding of snow and truth of statements such as "snow is white" and "the snowman is white" manifests out of this network of associations.

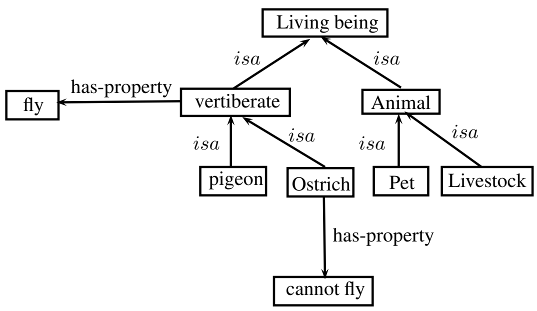

Figure 12.1: A contradiction to inherited property.

12.2.3 Semantic Nets and Natural Language Processing

Much of the research in network representation has been done in the field of Natural Language understanding (NLU). Often, the natural language understanding requires the understanding of the common sense, the ways in which the physical objects behave, the interactions that occur between humans, and the ways in which the human institutions are organized. A natural language understanding program must understand the intentions, beliefs, hypothetical reasoning, plans, and goals embedded in the natural language text. Due to these, the language understanding has been the driving force for knowledge representation.

The NLU programs define the words of English language in terms of other words, like the English dictionary does, rather than defining in terms of primitive words or axioms. Thus, to understand the meaning of a word we traverse a network of words until we understand the meaning of the required word.

12.3 Conceptual Graphs

Although there is no accepted standard for semantic network representations, but some thing which is very close to the goal is *Conceptual Graphs*. It is portrayal of mental perception which consists of basic primitive concepts and relationships which exists between them. The conceptual graphs may be regarded as formal building blocks of Semantic networks. When they are linked together, they form a more complex and useful network.

Simmons (1973) suggested primitives to represent standard relationships, by using the *case structure* of English verbs. In the verb oriented approach, links define the roles played by nouns and noun phrases in action of the sentence. Case relationships includes: agent, object, instrument, location, and time.

Using this approach, "Rajan eats noodles with fork" can be represented by conceptual graph shown in figure 12.2.

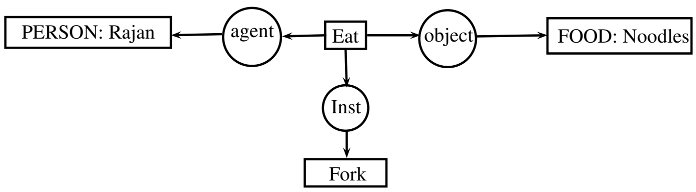

Figure 12.2: Conceptual Graph-I.