

Introduction to Semantic Networks and Description Logics – Outline

Semantic Networks and Description Logics

Introduction

Knowledge Representation and Reasoning

Jan 12, 2005

Motivation & History

Semantic Networks

Frame Systems

Outlook: The main ideas

Motivation & History

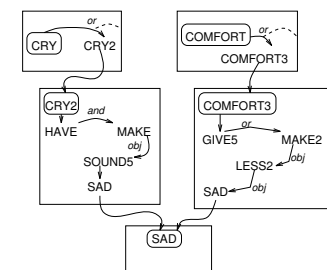
Motivation & History

- ▶ Knowledge about **word meanings** and **concepts** is (probably) organized as a **network** – similar to the organization of an encyclopedia with a lot of links
- ▶ When one wants to **represent** such a body of knowledge, we need a representation method/scheme/formalism
- ▶ **Semantic Networks** (first proposed by Quillian 67)
- ▶ **Frame Systems** (Minsky 81)
- ▶ **Structural Inheritance Networks** and **Description Logics** (Brachman 78)

Semantic Networks

Example: Quillian's Semantic Memory

- ▶ **Question:** How is conceptual knowledge organized?
- ▶ **Concrete Task:** Compare and contrast word meanings
- ▶ **Inferential mechanism:** Spreading activation

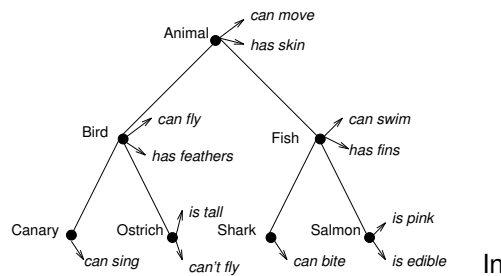


Generated sentences:

CRY2 IS AMONG OTHER THINGS TO
MAKE A SAD SOUND.
TO COMFORT3 CAN BE TO MAKE2
SOMETHING LESS2 SAD.

Another Example: Semantic Networks with Inheritance

- ▶ **Idea:** Knowledge is organized **hierarchically** using an **ISA-link**
- ▶ **Idea:** Economic representation – general attributes are stored at the most general concept
- ▶ **Inheritance:** Attributes are inherited along the hierarchy
- ▶ **Overriding:** Is it possible to override general attributes



psychological experiments, the question *Can canaries sing?* was answered faster than the question *Do canaries have feathers?*

Semantic Networks – Advantages & Disadvantages

- ▶ Claimed **advantages**
 - ▶ More **natural** representation than logic (using meaning axioms)
 - ▶ Higher **cognitive adequacy** than logic-based formalisms
 - ▶ More **efficient** inference algorithms (graph algorithms instead of resolution)
 - ▶ Higher **expressiveness** than logic (because of overriding)
- ▶ Possible **disadvantages**
 - ▶ The meaning of nodes and links is not clear and only defined **procedurally** by the inference algorithms
 - ▶ There is no **semantics** of semantic networks

Frame Systems: The idea

- ▶ In semantic networks everything is distributed
- ▶ Instead, try to cluster all things belonging to a **scenarium** together in a **frame**:
 - ▶ defining properties
 - ▶ default properties
 - ▶ procedural knowledge
 - ▶ ...
- ▶ Then **match** frame against actual situation
 - ▶ use information in the frame to fill in missing details
 - ▶ explain differences
 - ▶ apply procedural knowledge

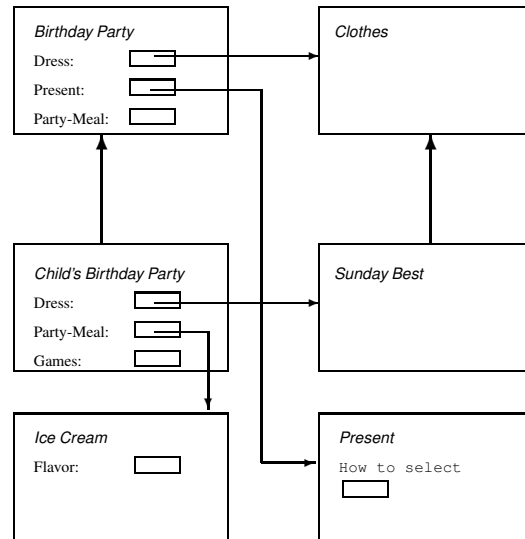
Example: Birthday party

The meaning of a child's birthday is very poorly approximated by any dictionary definition like "a party assembled to celebrate a birthday" [...]. This lacks all the flavor of the culturally required activities. Children know that the "definition" should include more specifications, the particulars of which can normally be assumed by the way of default assignments (Minsky 81):







Dress:	Sunday best
Present:	must please host
Games:	hide and seek, pin tail on donkey
Decor:	balloons, favors, crepe-paper
Party-meal:	cake, ice-cream, soda, hot dogs

...

Frame System



Literature I

-  Baader, F., D. Calvanese, D. L. McGuinness, D. Nardi, and P. F. Patel-Schneider, *The Description Logic Handbook: Theory, Implementation, Applications*, Cambridge University Press, Cambridge, UK, 2003.
-  Sowa, J., *Principles of Semantic Networks*, Morgan Kaufmann, San Mateo, CA, 1991.
-  Brachman, R. J. and Levesque, H. J. (ed.), *Readings in Knowledge Representation*, Morgan Kaufmann, Los Altos, 1985.
-  Findler, N. V., *Associative Networks: Representation and Use of Knowledge by Computers*, Academic Press, New York, 1979.
-  Quillian, M. R., Word Concepts: A Theory and Simulation of Some Basic Semantic Capabilities, *Behavioral Science* **12**: 410–430, 1967. Appears also in *Readings in Knowledge Representation*.
-  Minsky, M., A Framework for Representing Knowledge, in: J. Haugeland (ed.), *Mind Design*, The MIT Press, Cambridge, MA, 1981, S. 95–128. Also in *Readings in Knowledge Representation*.

Semantic Networks and Frames: Important Ideas

- ▶ **Hierarchical** organization
- ▶ **Object-centered** organization
- ▶ **Restricting the expressiveness** wrt. full first-order logic
- ▶ **Inheritance** (strict, non-strict, ...)
- ▶ **Using descriptions** in the inference process to recognize things
- ▶ **Note**: Nowadays semantic networks and frames are hardly used anymore – but the above ideas are still employed

Literature II

-  B. Nebel, Frame-Based Systems, in: Robert A. Wilson and Frank Keil (eds.), *MIT Encyclopedia of the Cognitive Sciences*, MIT Press, Cambridge, MA, 1999.