Knowledge Representation

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Language and Conceptualization
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What is knowledge?

1. The state or fact of knowing.
2. **Familiarity, awareness, or understanding gained through experience or study.**
3. **The sum or range of what has been perceived, discovered, or learned.**
4. Learning; erudition: teachers of great knowledge.
5. **Specific information about something.**
6. Carnal knowledge.

Why do we want to represent it?

Knowledge Representation: Formal reconstruction of knowledge and its implementation.

- Encyclopedias are not always optimal
- $\rightarrow$ Lots of redundant information, Cross-references, search for properties
- For Knowledge transmission, use something like our brain
- Feed computers with knowledge
- $\rightarrow$ Let the computer think for us: intelligent action requires 70.000 ± 20.000 knowledge units per subject area.

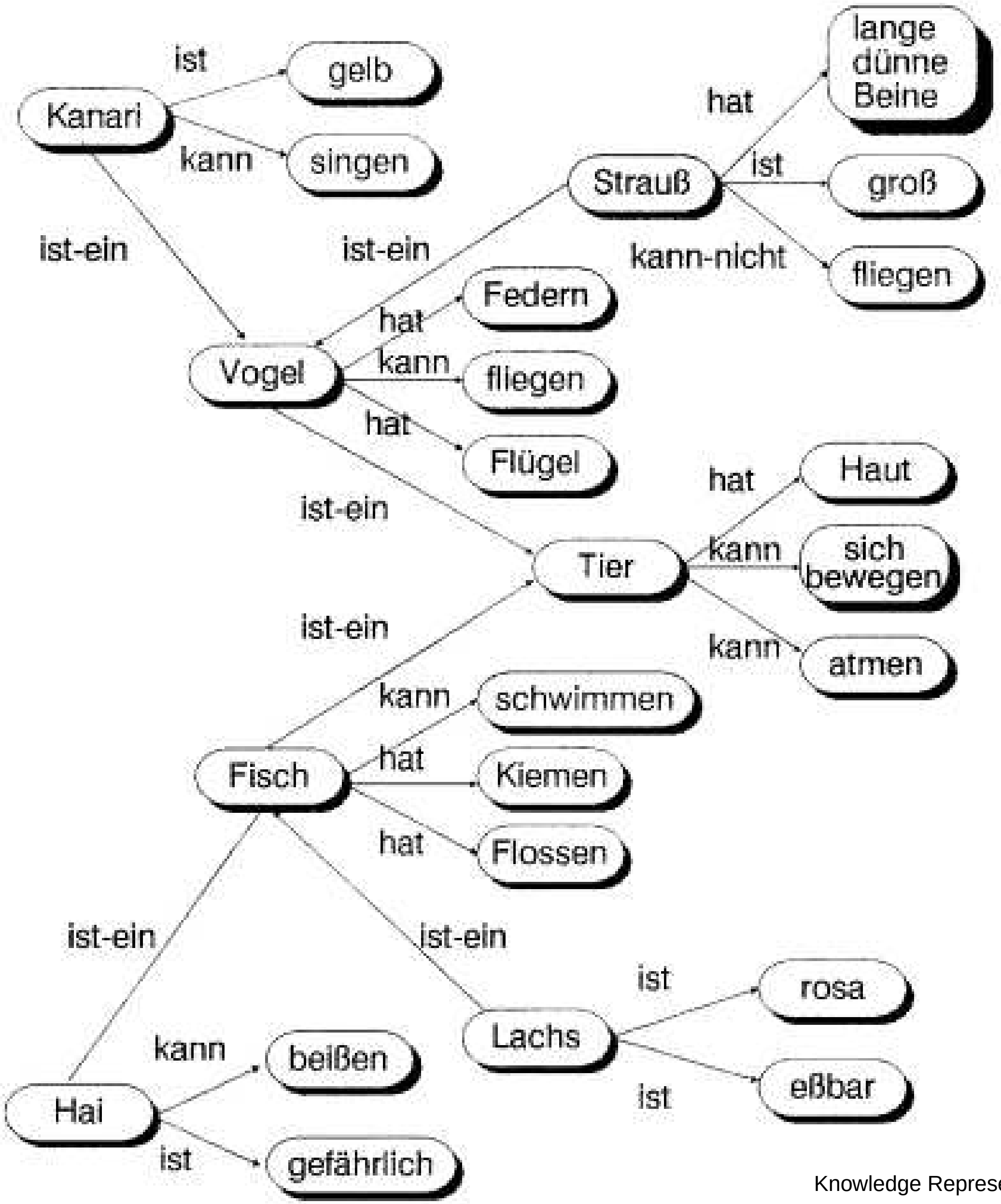
What do we need to represent?

Like in nature: how do we recognize things?
Define the criteria we need: optional and needed ones.

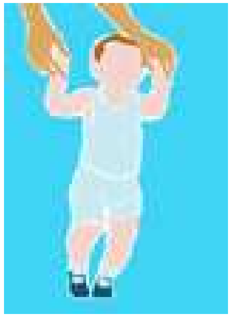
- Mouse: Mammalian
- Size: small
- Shape: ears, muzzle, short legs
- Exact acquisition of dimensions and relations

Use of fuzzy logic to identify slightly different elements

Semantic Network



How would we do that?

- Automatic acquisition still very problematic: semantic recognition in speech and pictures.
- What we need are *double linked elements*: to go from the mouse to its properties and to get from the properties to the mouse.
- Classify objects according to their properties: Let’s try to define these properties

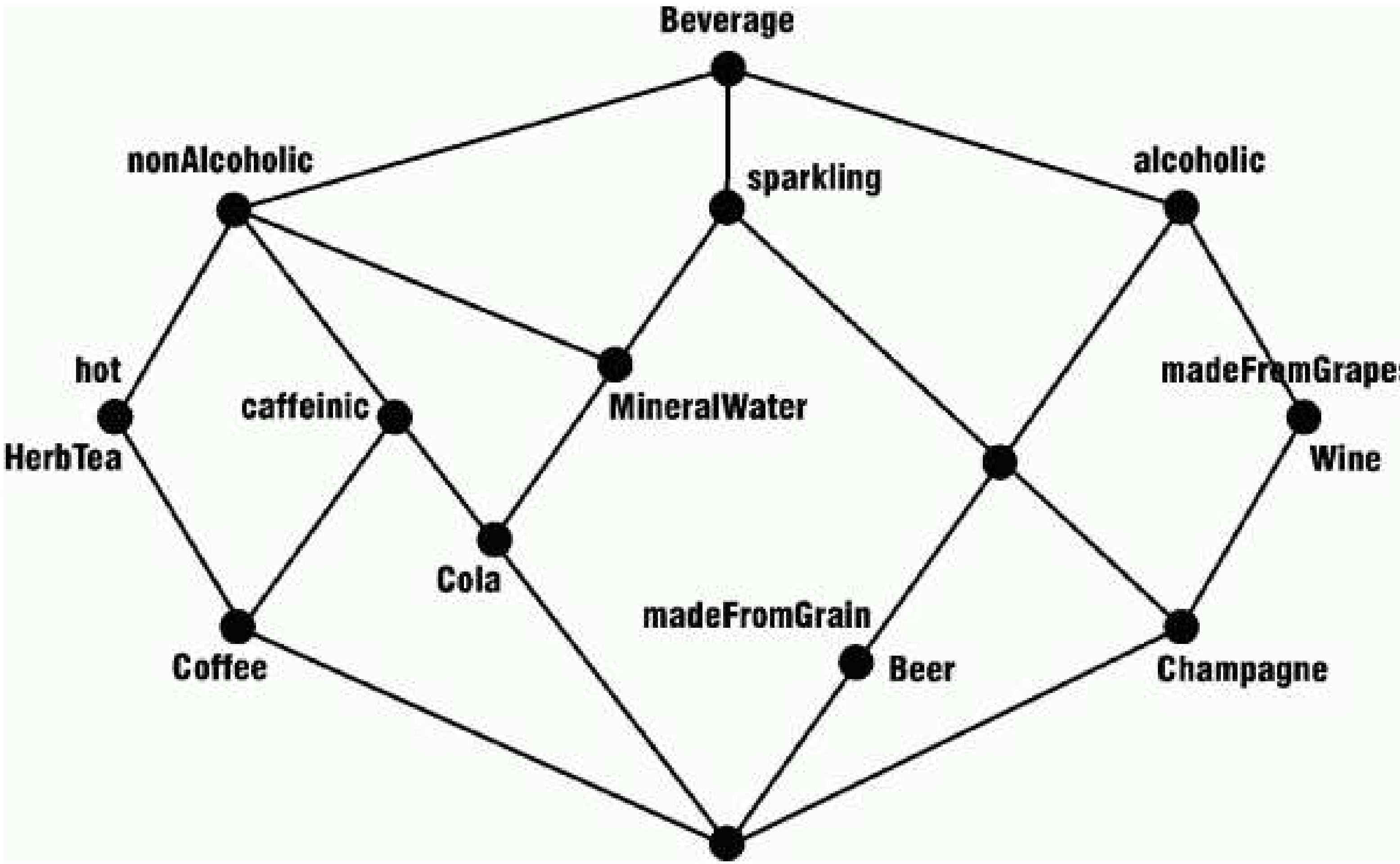
Ontology

- The subject of ontology is the study of the categories of things that exist or may exist in some domain.
- The product of such a study, called an **ontology**, is a catalog of the types of things that are assumed to exist in a domain of interest **D** from the perspective of a person who uses a language **L** for the purpose of talking about **D**.
- An uninterpreted logic, such as predicate calculus, conceptual graphs, or KIF, is ontologically neutral.
- It imposes no constraints on the subject matter or the way the subject may be characterized.

Ontology (2)

- By itself, logic says nothing about anything, but the combination of logic with an ontology provides a language that can express relationships about the entities in the domain of interest.
- An **informal ontology** may be specified by a catalog of types that are either undefined or defined only by statements in a natural language (Mouse example).
- A **formal ontology** is specified by a collection of names for concept and relation types organized in a partial ordering by the type-subtype relation (Drinks example).

Ontology (3)


Beverage
nonAlcoholic
sparkling
alcoholic
hot
caffeinic
MineralWater
madeFromGrapes
HerbTea
Wine
Cola
madeFromGrain
Coffee
Beer
Champagne

Ontology (4)

- Formal ontologies are further distinguished by the way the subtypes are distinguished from their supertypes: an **axiomatized ontology** distinguishes subtypes by axioms and definitions stated in a formal language, such as logic or some computer-oriented notation that can be translated to logic;
- a **prototype-based ontology** distinguishes subtypes by a comparison with a typical member or prototype for each subtype. Large ontologies often use a mixture of definitional methods: formal axioms and definitions are used for the terms in mathematics, physics, and engineering; and prototypes are used for plants, animals, and common household items.

Uses of Knowledge-Based Systems

- Interpretation → Data-Mining
- Diagnosis
- Planing
- Robots
- Belief-Networks: Bayes-Nets
- Artificial Intelligence

Examples

feature	**scope of feature value**
name	letter string
age	0–100 years
sex	male, female
height	0–2.10 m
weight	0–150 kg
address	city name
occupation	list of occupations
telephone number	integer

Examples: SQL

Use relational algebra to define relational databases (tables) and use Structured Query Language (SQL) to store and retrieve information.

```
SELECT name FROM people
WHERE weight > ’100’ AND height < ’1.75’
     AND ( address = ’Darmstadt’
     OR address  = ’Griesheim’ );
```

Examples: PROLOG

```
father(paul, rob).        father(rob, bev).
father(rob, ally).        father(jeff, aaron).
mother(mary, rob).        mother(dorothy, bev).
mother(dorothy, ally). mother(ally, aaron).

parent(M,C) :- mother(M,C).
parent(F,C) :- father(F,C).
grandparent(Gparent, Gchild) :-
     parent(Gparent,X), parent(X, Gchild).

:- sibling(bev, ally).
:- mother(M, rob) ; father(F, rob).
:- parent(X, rob).
```

Thank you for your attention!

References

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[4] http://www.jfsowa.com/ontology/

[5] TOSCANA —a Graphical Tool for Analyzing and Exploring Data

[6] The Captcha Project http://www.captcha.net/