REASONING SYSTEMS FOR CATEGORIES

- Categories are the primary building blocks of large-scale knowledge representation schemes.
- This topic describes systems specially designed for organizing and reasoning with categories.
- There are two types of reasoning systems:
  1. **Semantic networks**
  2. **Description logics**

Semantic networks

- Visualize knowledge-base in patterns of interconnected nodes and arcs
- Efficient algorithms for inferring of object on the basis of its category membership

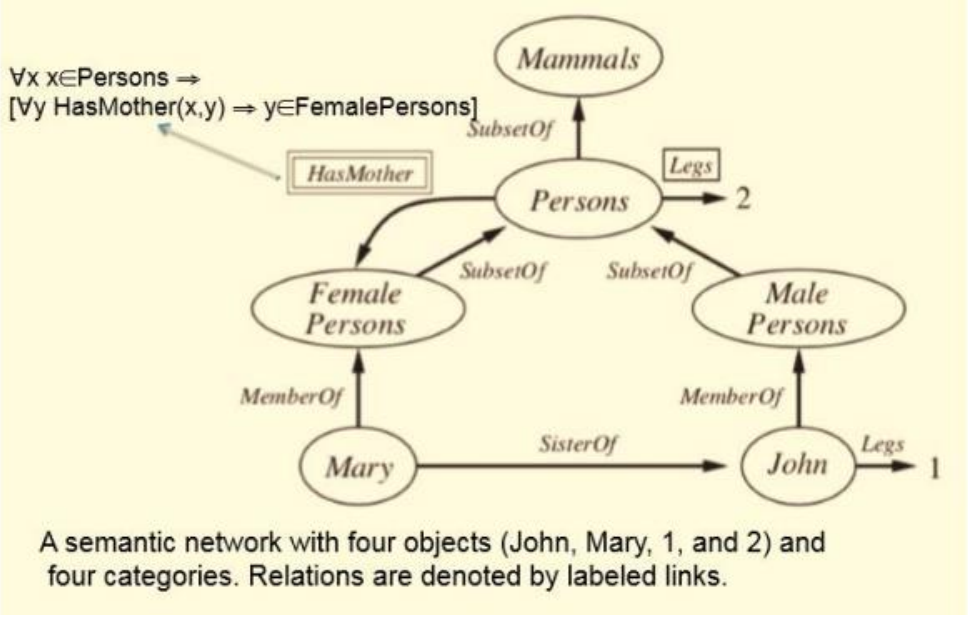
Description logics

- Formal language for constructing and combining category definitions
- Efficient algorithms to decide subset and superset relationships between categories.

SEMANTIC NETWORKS

- In 1909, Charles S. Peirce proposed a graphical notation of nodes and edges called **existential graphs**
- A typical graphical notation displays object or category names in ovals or boxes, and connects them with labeled arcs/links
- For Example:
  - MemberOf link between Mary and FemalePersons, corresponding to the logical assertion **Mary ∈ FemalePersons**
  - SisterOf link between Mary and John corresponds to the assertion **SisterOf (Mary, John)**
  - connect categories using SubsetOf links,

SEMANTIC NETWORKS EXAMPLE



A semantic network with four objects (John, Mary, 1, and 2) and four categories. Relations are denoted by labeled links.

FEATURES OF SEMANTIC NETWORKS

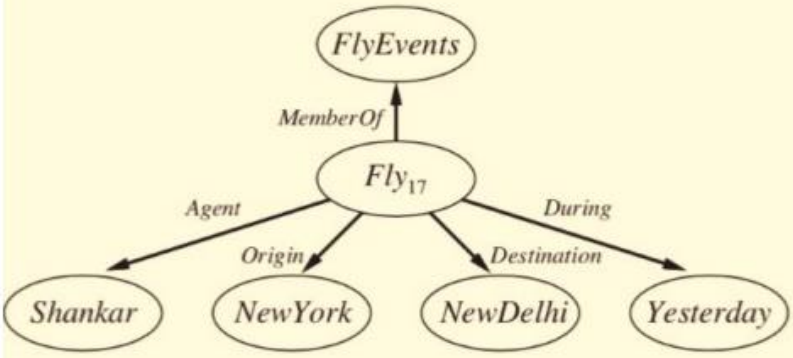
- Allows for inheritance reasoning
  - Female persons inherit all properties from person
  - Mary inherits the property of having two legs
- The simplicity and efficiency of this inference mechanism compared with logical theorem has been one of the main attractions of semantic networks.
- Multiple Inheritance becomes complicated because two or more conflicting values for answering the query
- For this reason, multiple inheritance is banned in some **object-oriented programming** (OOP) languages, such as Java

- Another form of inference is the use of inverse links
- Example: HasSister is the inverse of SisterOf

- Drawback of semantic network is that the links between bubbles represent only *binary* relations.

- For example, the sentence Fly(Shankar, NewYork, NewDelhi, Yesterday) cannot be asserted directly in a semantic network.

- *But can* obtain the effect of n-ary assertions by reifying the proposition



Semantic network showing representation of logical assertion fly()

- They are logical notations that are designed to describe definitions and properties about categories
- It is to formalize the semantic network
- Principal inference task is
  - Subsumption: checking if one category is the subset of another by comparing their definitions
  - Classification: checking whether an object belongs to a category.
  - Consistency: whether the category membership criteria are logically satisfiable

- The CLASSIC language is a typical description logic
- Any CLASSIC can be written in FOL
- For example, to say that bachelors are unmarried adult males we would write
  - **Bachelor = And (Unmarried , Adult , Male)**
- The equivalent in first-order logic would be
  - **$Bachelor(x) \Leftrightarrow Unmarried(x) \wedge Adult(x) \wedge Male(x)$**