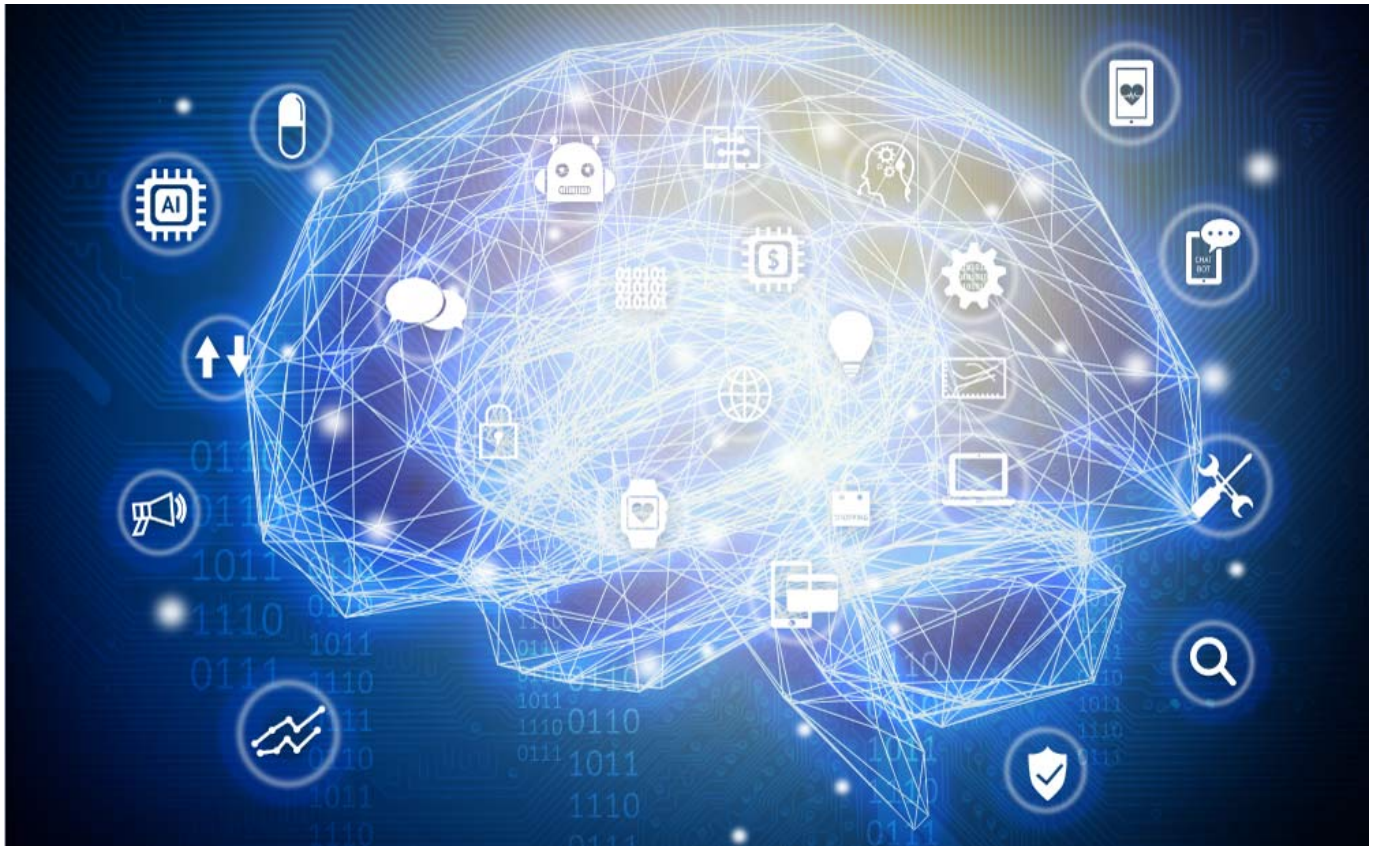


Reasoning Systems for Categories

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**

Reasoning systems

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

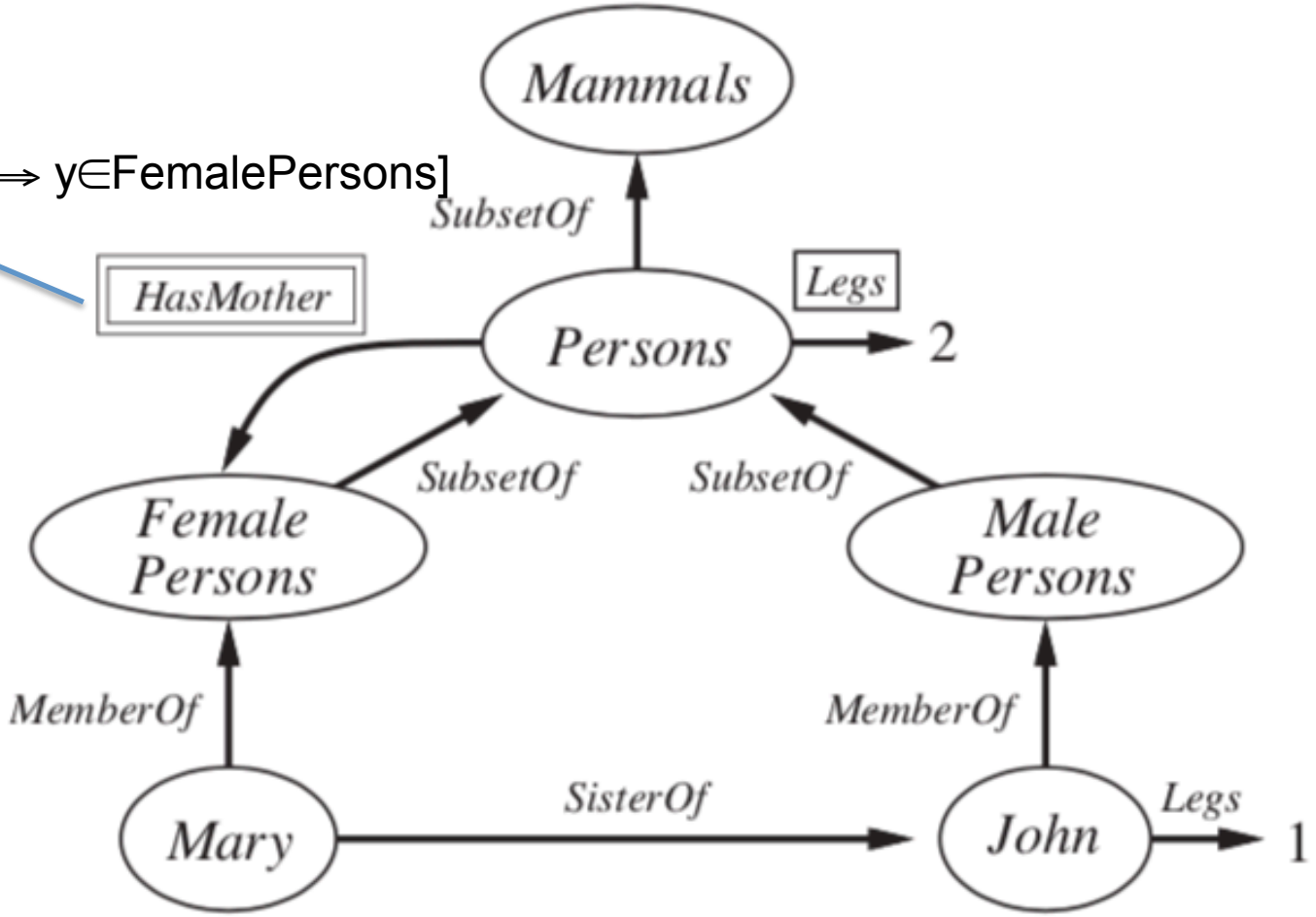
- Formal language for constructing and combining category definitions
- Efficient algorithms to decide subset and superset relationships between categories.

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 Network Example

$\forall x\ x \in Persons \Rightarrow$
$[\forall y\ HasMother(x,y) \Rightarrow y \in FemalePersons]$



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

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

Semantic Networks

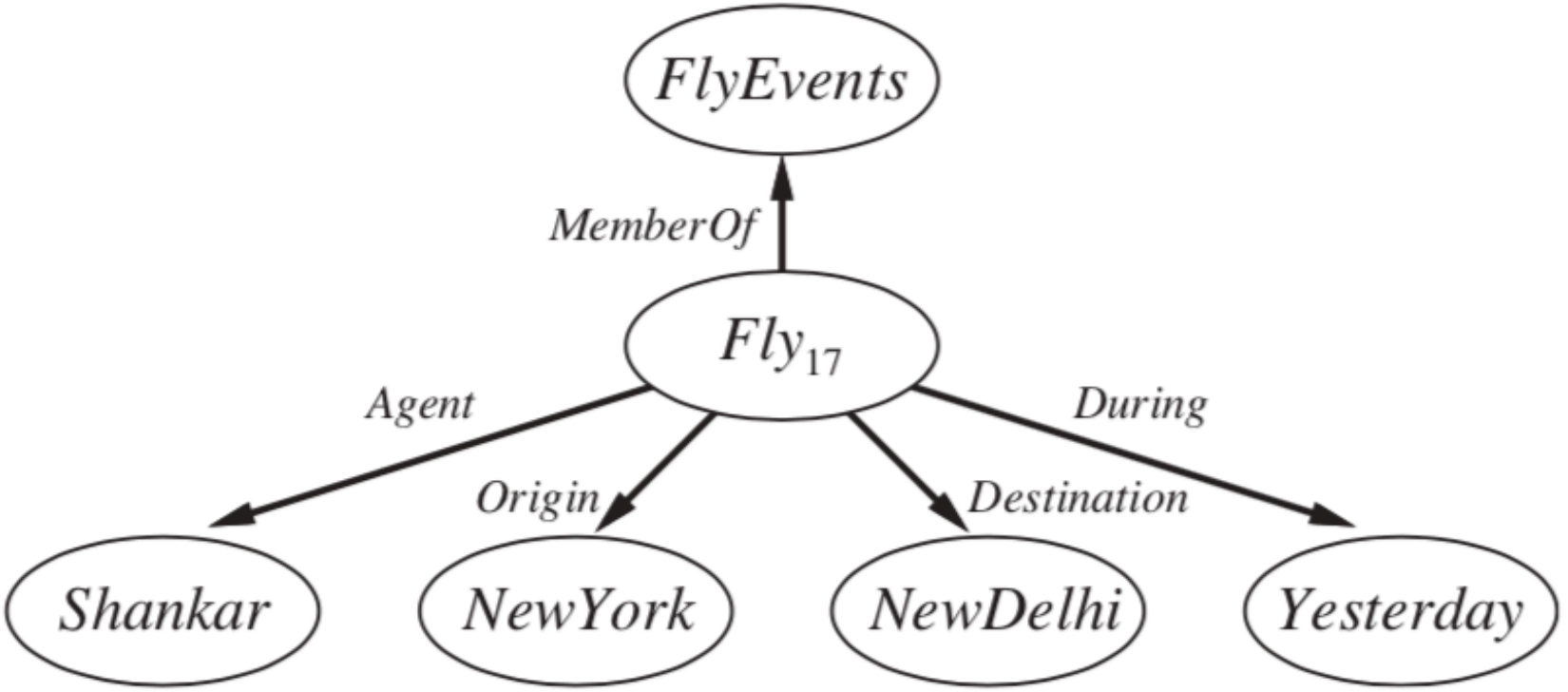
- Another form of inference is the use of inverse links
- Example: HasSister is the inverse of SisterOf

- 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 Networks



Semantic network showing representation of logical assertion fly()

Semantic Networks

- Ability to **override** the **default** values
- Example:
  - John has 1 leg despite the fact that all persons have 2 legs
  - This would be contradiction in a strictly logical KB.

Description logics

- 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

Description logics

- 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
  - **$Bachelor(x) \Leftrightarrow Unmarried(x) \wedge Adult(x) \wedge Male(x)$**

The syntax of descriptions in a subset of the CLASSIC language.

$$
\begin{aligned}
Concept &\rightarrow \mathbf{Thing} \mid ConceptName \\
&\mid \mathbf{And}(Concept, \ldots) \\
&\mid \mathbf{All}(RoleName, Concept) \\
&\mid \mathbf{AtLeast}(Integer, RoleName) \\
&\mid \mathbf{AtMost}(Integer, RoleName) \\
&\mid \mathbf{Fills}(RoleName, IndividualName, \ldots) \\
&\mid \mathbf{SameAs}(Path, Path) \\
&\mid \mathbf{OneOf}(IndividualName, \ldots) \\
Path &\rightarrow [RoleName, \ldots]
\end{aligned}
$$


THANK
YOU
GRACIAS
ARIGATO
SHUKURIA
DANKSCHEEN
BIYAN
SHUKRIA
TINGKI
YAQHANYELAY
TASHAKKUR ATU
SUKSAMA
EKHMET
MEHRBANI
GRAZIE
MAAKE
KOMAPSUMNIDA
JUSPAXAR
GOZAIMASHITA
EFCHARISTO
BOLZÏN
MERCI
SPASSIBO
SNACHALHUYA
NUHUN
CHALTU
WABEEJA
MAITEKA
YUSPAGARÀTAM
HUI
DHANYAADAAD
AHHA
ATTO
MERSI
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