Structured Knowledge

Type of Knowledge Structure

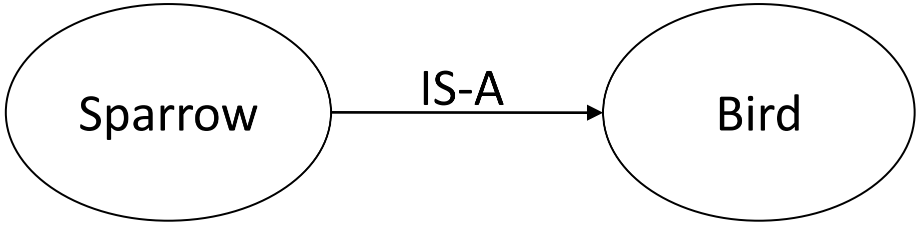
- Weak Slot - Filler Structure
  - Semantic Nets
  - Frame
- Strong Slot - Filler Structure
  - Scripts
  - Conceptual Dependency

Semantic Nets

- Semantic network or a semantic net is a structure for representing knowledge as a pattern of interconnected nodes and arcs.
- It is also representation of knowledge.
- Node in the semantic net represent either
  - Entities,
  - Attributes,
  - State or Events.
- Arcs in the net give the relationship between the nodes.
- Labels on the arc specify what type of relationship actually exits.

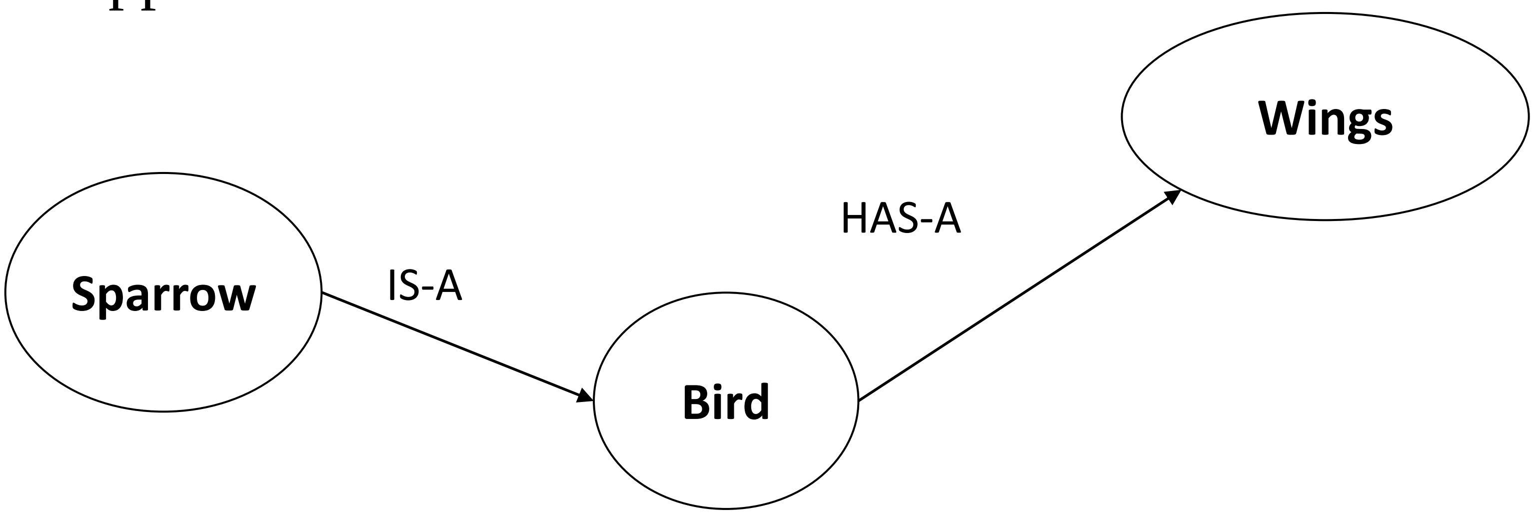
Example: Semantic networks…

- "A sparrow is a bird"
  - Two concepts: "sparrow" and "bird"
  - sparrow is a kind of bird, so connect the two concepts with a *IS-A relation*
    - This is an higher-lower relation or abstract-concrete relation



Example: Semantic networks…

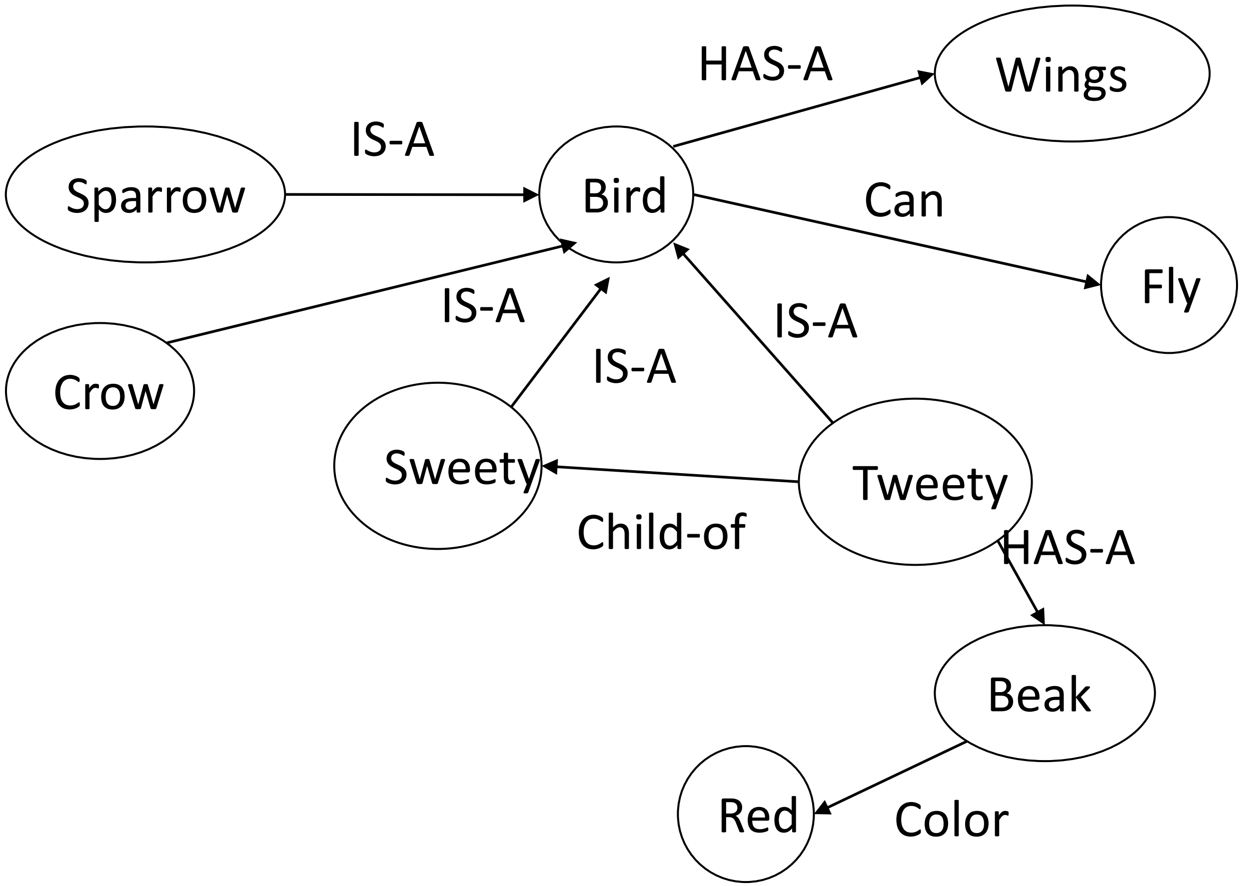
- "A bird has wings"
  - This is a different relation: the part-whole relation
  - Represented by a HAS-A link or PART-OF link
  - The link is from whole to part, so the direction is the opposite of the IS-A link



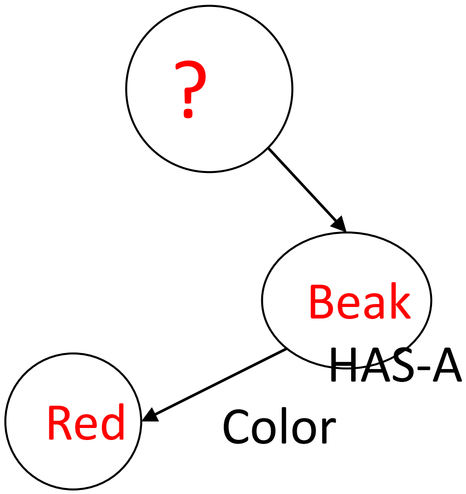
Example: Semantic Networks…

- Tweety and Sweety are birds
- Tweety has a red beak
- Sweety is Tweety’s child
- A crow is a bird
- Birds can fly
- Sparrow is a bird.
- Sparrow has a wing.

Example: Semantic networks…



Semantic networks can answer queries



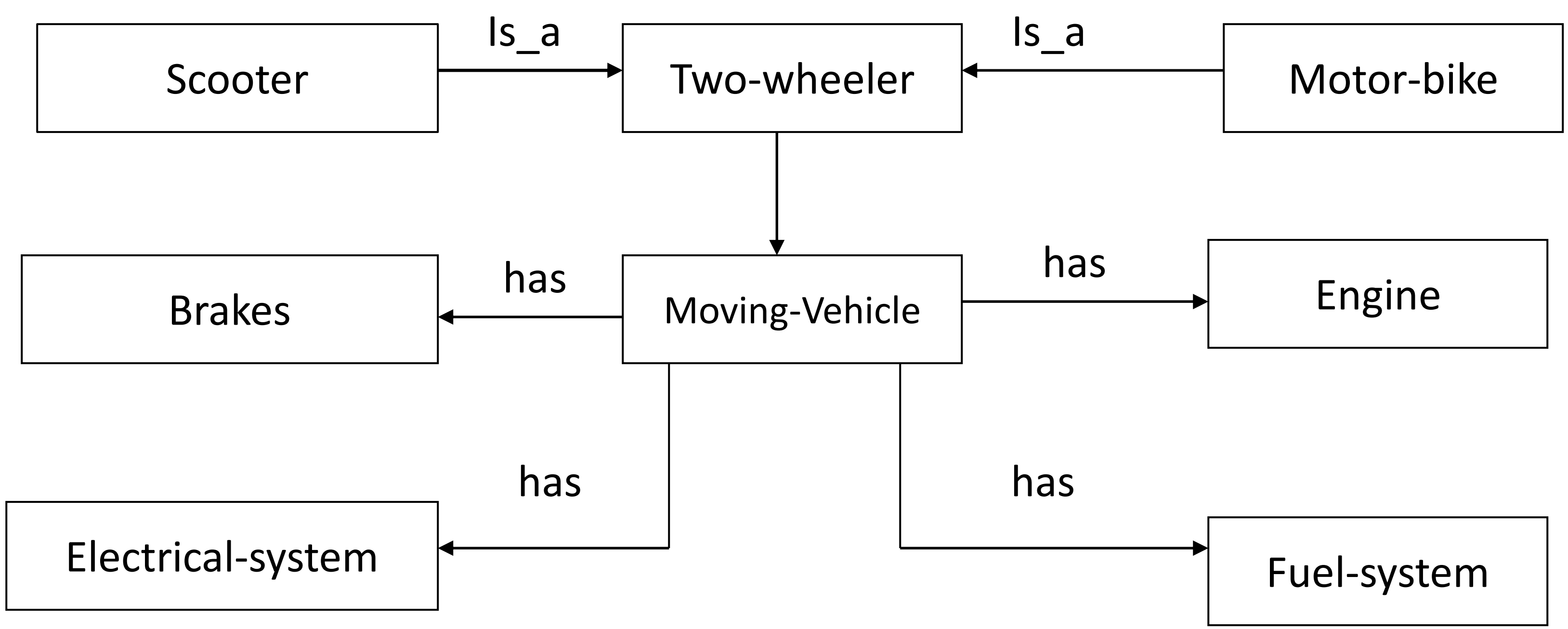
- *Query*: "Which birds have red beaks?"
- *Answer*: Tweety
- *Method*: Direct match of subgraph

- *Query*: "Can Tweety fly?"
- *Answer*: Yes
- *Method*: Following the IS-A link from "Tweety" to "bird" and the property link of "bird" to "fly"

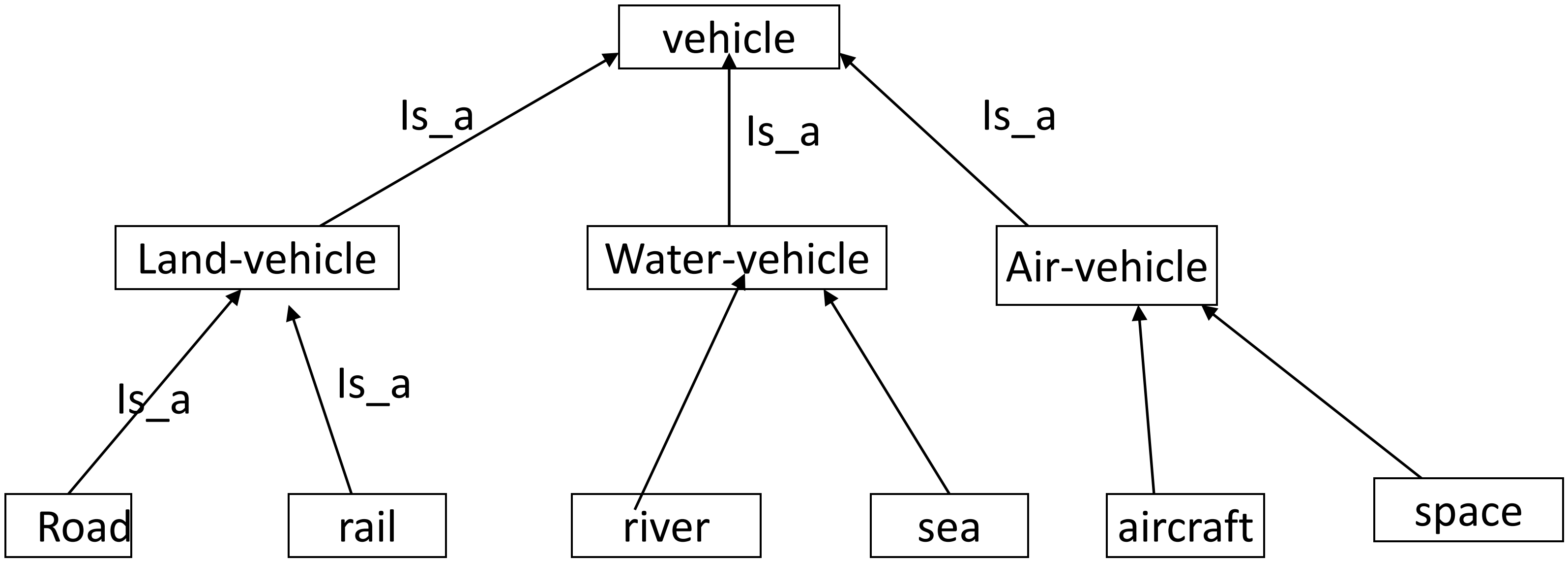
Example: Semantic Networks..

- Scooter is a two wheeler.
- Motor-bike is a two wheeler.
- Motor-bike is a moving-vehicle.
- Moving –vehicle has engine.
- Moving-vehicle has electrical system.
- Moving-vehicle has fuel system.

Example: Semantic Networks…



Hierarchical Structure



Give semantic network representation for the following facts –

(i) Raja is a bank manager

(ii) Raja works in SBI located in M.I.T.S. campus.

(iii) Raja is 26 years old

(iv) Raja has blue eyes

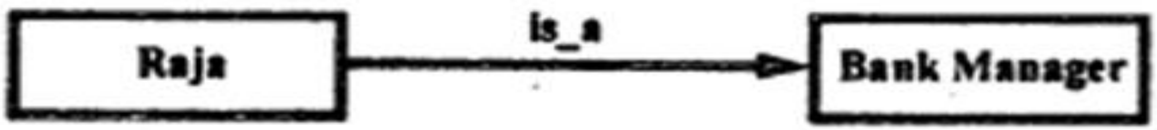
(v) Raja is taller than Piyush.

Ans. These facts can be represented in semantic network as follows –

(i) Raja is a bank manager.

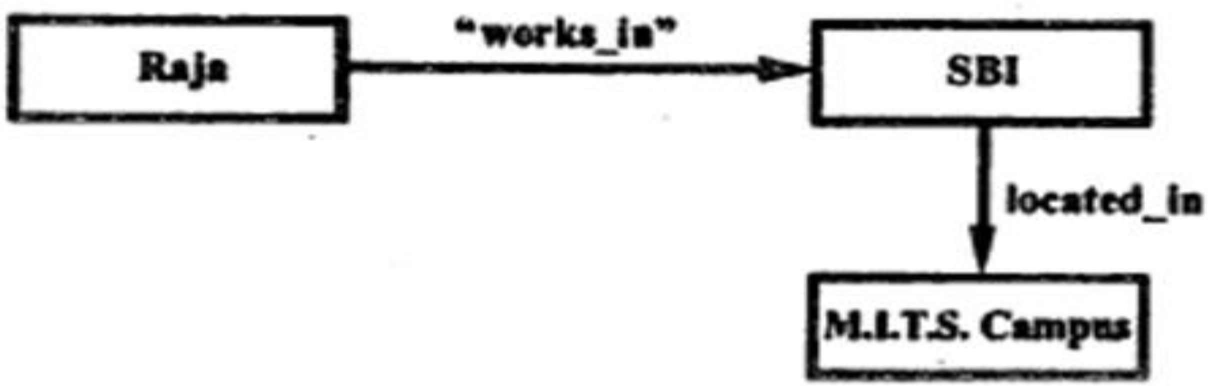
Here link between nodes is "is_a".

So, it can be represented as –



(ii) Raja works in SBI located in M.I.T.S. campus.

Here we will have two links "works_in and located_in.

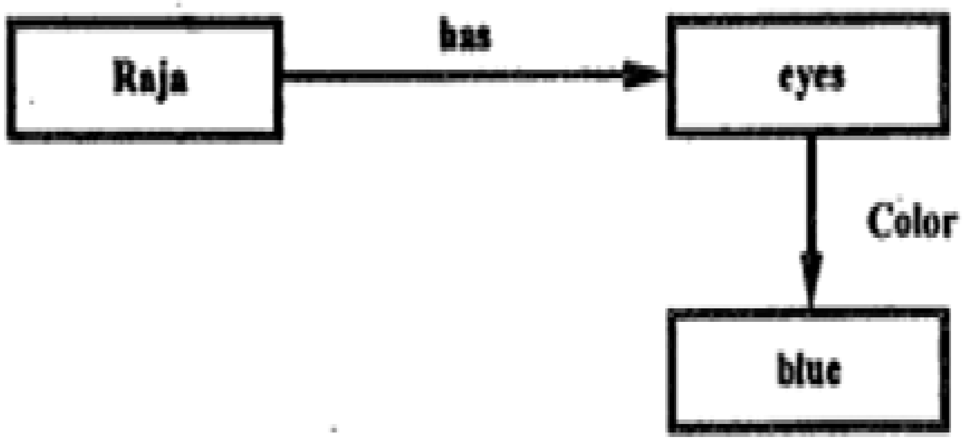


(iii) Raja is 26 years old.

In this only one link "age" shows the relation between Raja and 26 that 26 is age of Raja.

Indirectly one can say that Raja is 26 years old.

(iv) Raja has blue eyes.



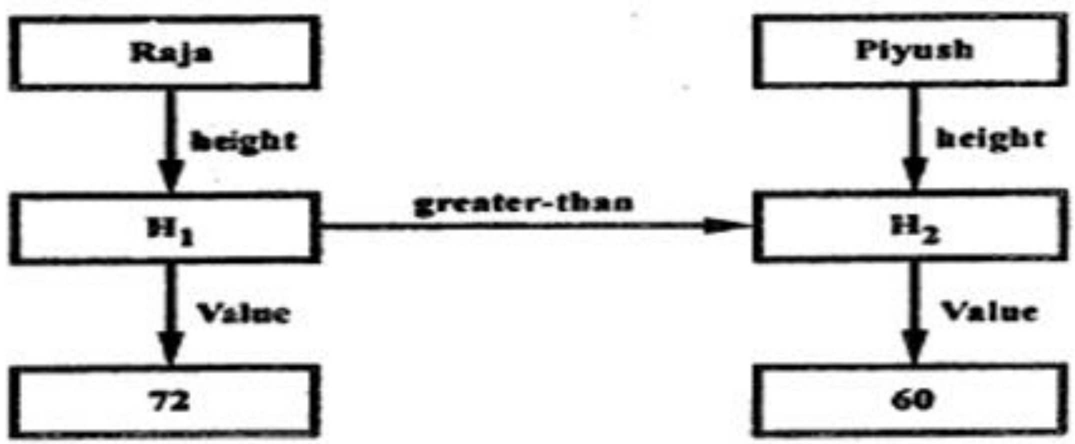
This shows that Raja has eyes and color of eyes is blue, so Raja has blue eyes.

(v) Raja is taller than Piyush.

Here, we have little bit different representation that Raja and Piyush have height H_1 and H_2 respectively.

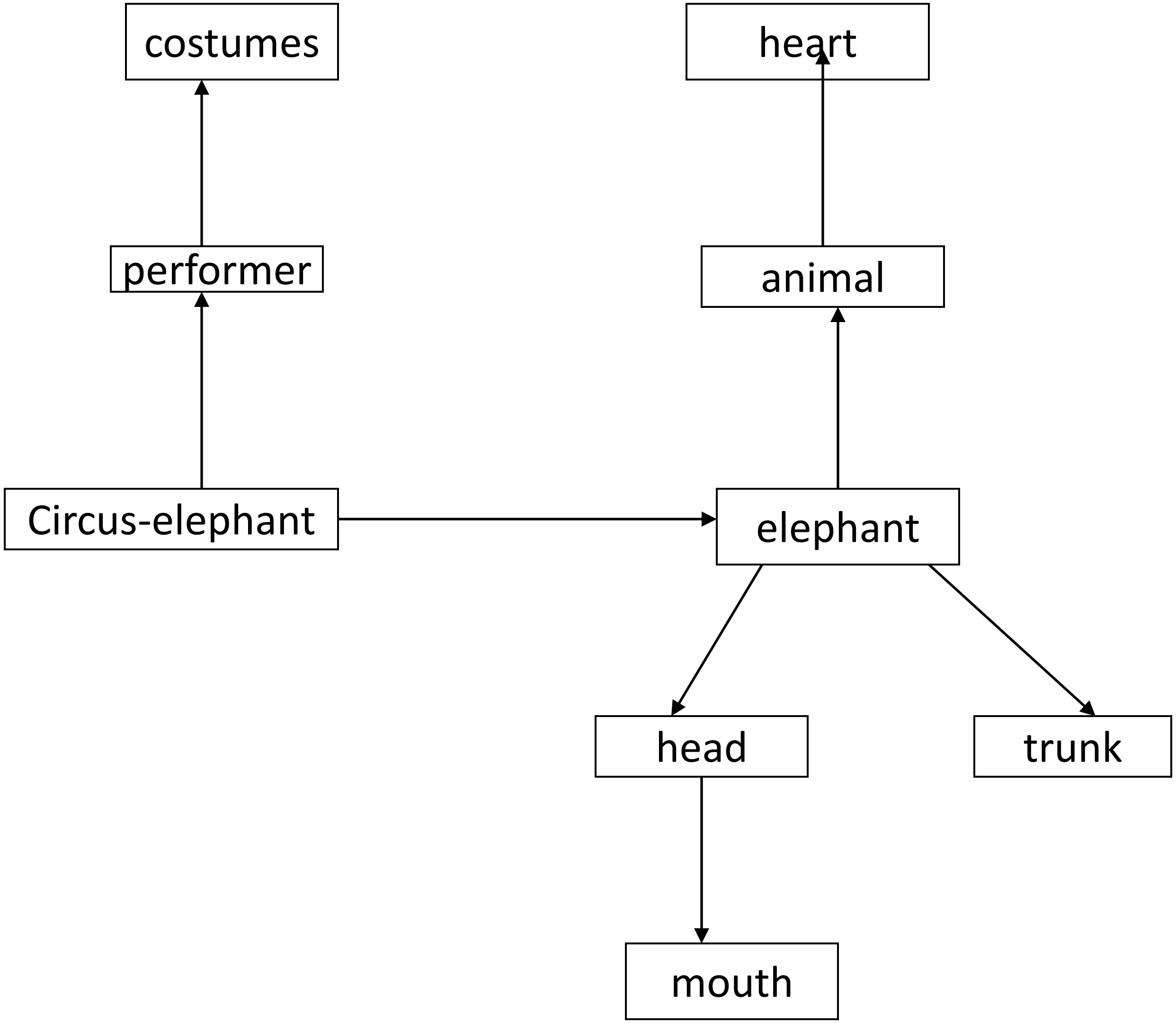
Next, we show that height of Raja is greater than height of Piyush. So, Raja is taller than Piyush.

If we would have statement that Raja has height 6 feet and Piyush has height 5 feet, i.e., if we wish to represent values too then representation would be as follows –



Represent following information in Semantic net

- (is_a circus-elephant elephant)
- (has elephant head)
- (has elephant trunk)
- (has head mouth)
- (is_a elephant animal)
- (has animal heart)
- (is_a circus-elephant performer)
- (has performer costumes)


costumes
heart
performer
animal
Circus-elephant
elephant
head
trunk
mouth

Semantic networks

- <u>Advantages of semantic networks</u>
  - Simple representation, easy to read
  - Associations possible
  - Inheritance possible
- <u>Disadvantages of semantic networks</u>
  - A separate inference procedure (interpreter) must be build
  - The validity of the inferences is not guaranteed
  - For large networks the processing is inefficient

Partitioned Semantic Networks

- Hendrix developed the so-called **partitioned semantic network** to represent the difference between the description of an individual object or process and the description of a set of objects. The set description involves **quantification**.

- Hendrix partitioned a semantic network whereby a semantic network, loosely speaking, can be **divided** into one or more networks for the description of an individual.

Partitioned Semantic Networks

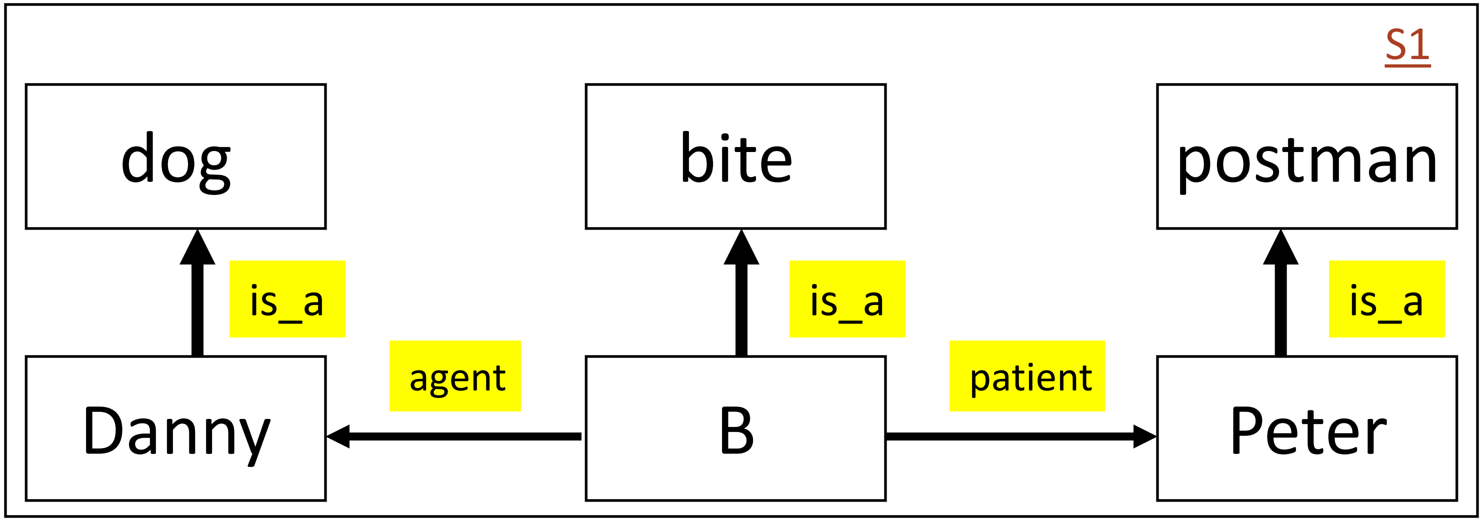
- The central idea of partitioning is to allow groups, nodes and arcs to be bundled together into units called **spaces** – fundamental entities in partitioned networks, on the same level as nodes and arcs (Hendrix).

- Every node and every arc of a network belongs to (or lies in/on) one or more spaces.

- Some spaces are used to encode 'background information' or generic relations; others are used to deal with specifics called 'scratch' space.

Partitioned Semantic Networks

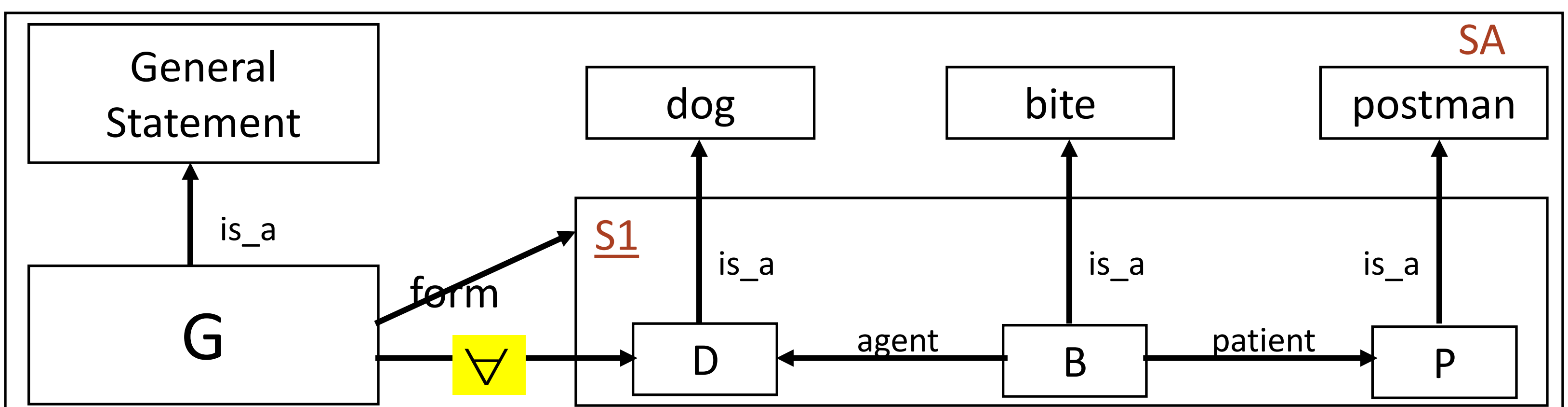
- Suppose that we wish to make a specific statement about a dog, Danny, who has bitten a postman, Peter:
  - " Danny the dog bit Peter the postman“
- Hendrix’s Partitioned network would express this statement as an ordinary semantic network:



Partitioned Semantic Networks

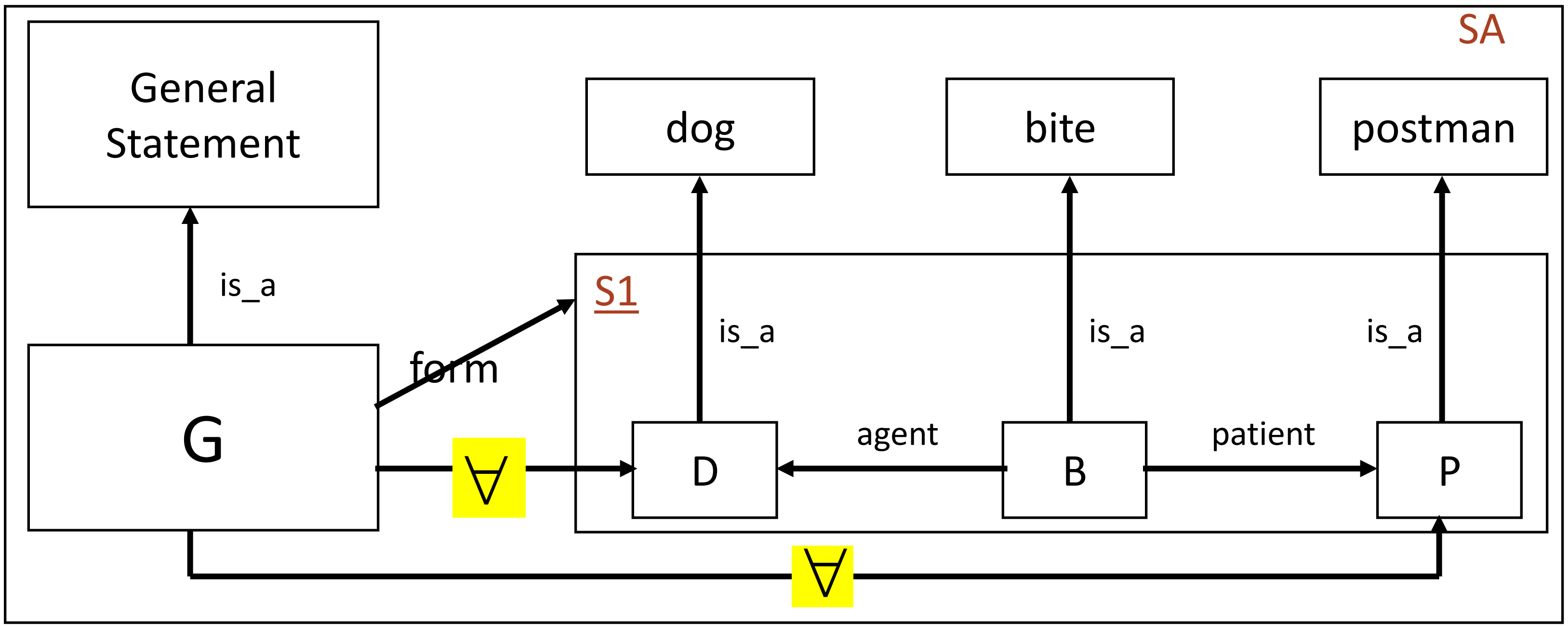
- Suppose that we now want to look at the statement:
  - "Every dog has bitten a postman"
- Hendrix partitioned semantic network now comprises two partitions SA and S1. Node G is an **instance** of the special class of general statements about the world comprising link statement, **form**, and one **universal quantifier**

$\forall$



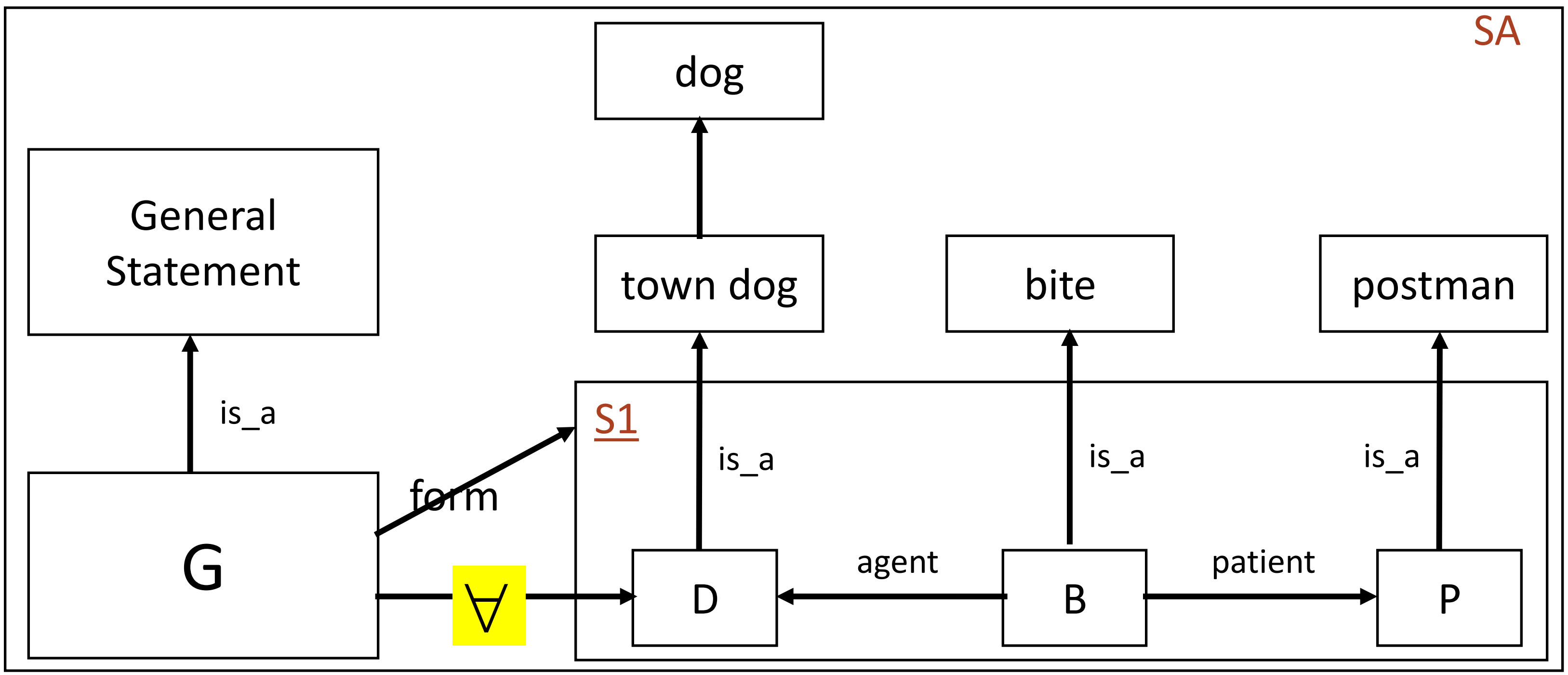
Partitioned Semantic Networks

- Suppose that we now want to look at the statement:
  - "Every dog has bitten every postman"



Partitioned Semantic Networks

- Suppose that we now want to look at the statement:
  - "Every dog in town has bitten the postman"



NB: 'ako' = 'A Kind Of'

Partitioned Semantic Networks

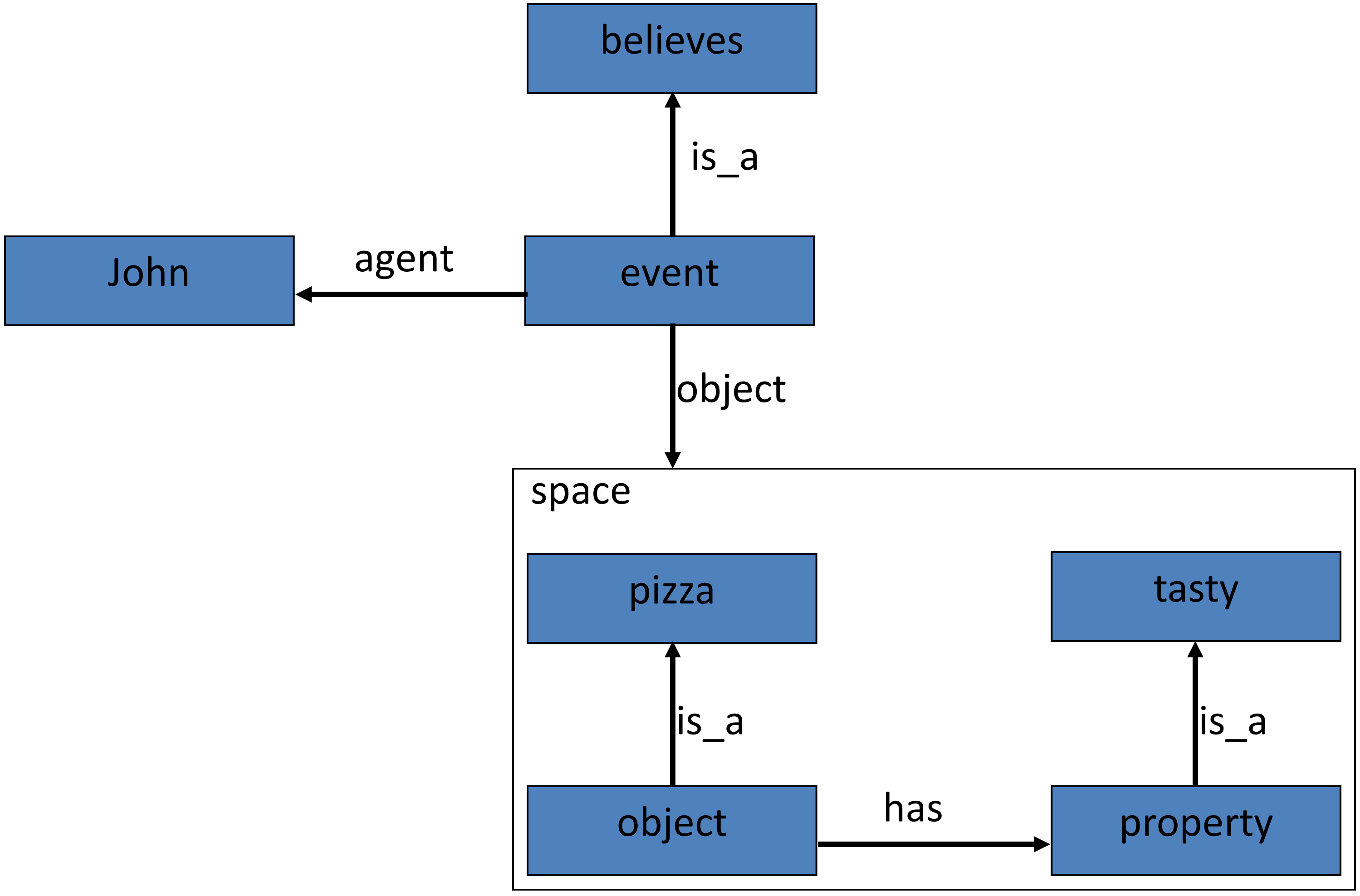
- The partitioning of a semantic network renders them more
  - **logically adequate**, in that one can distinguish between individuals and sets of individuals,
  - and indirectly more **heuristically adequate** by way of controlling the search space by delineating semantic networks.

- Hendrix's partitioned semantic networks-oriented formalism has been used in building natural language front-ends for data bases and for programs to deduct information from databases.

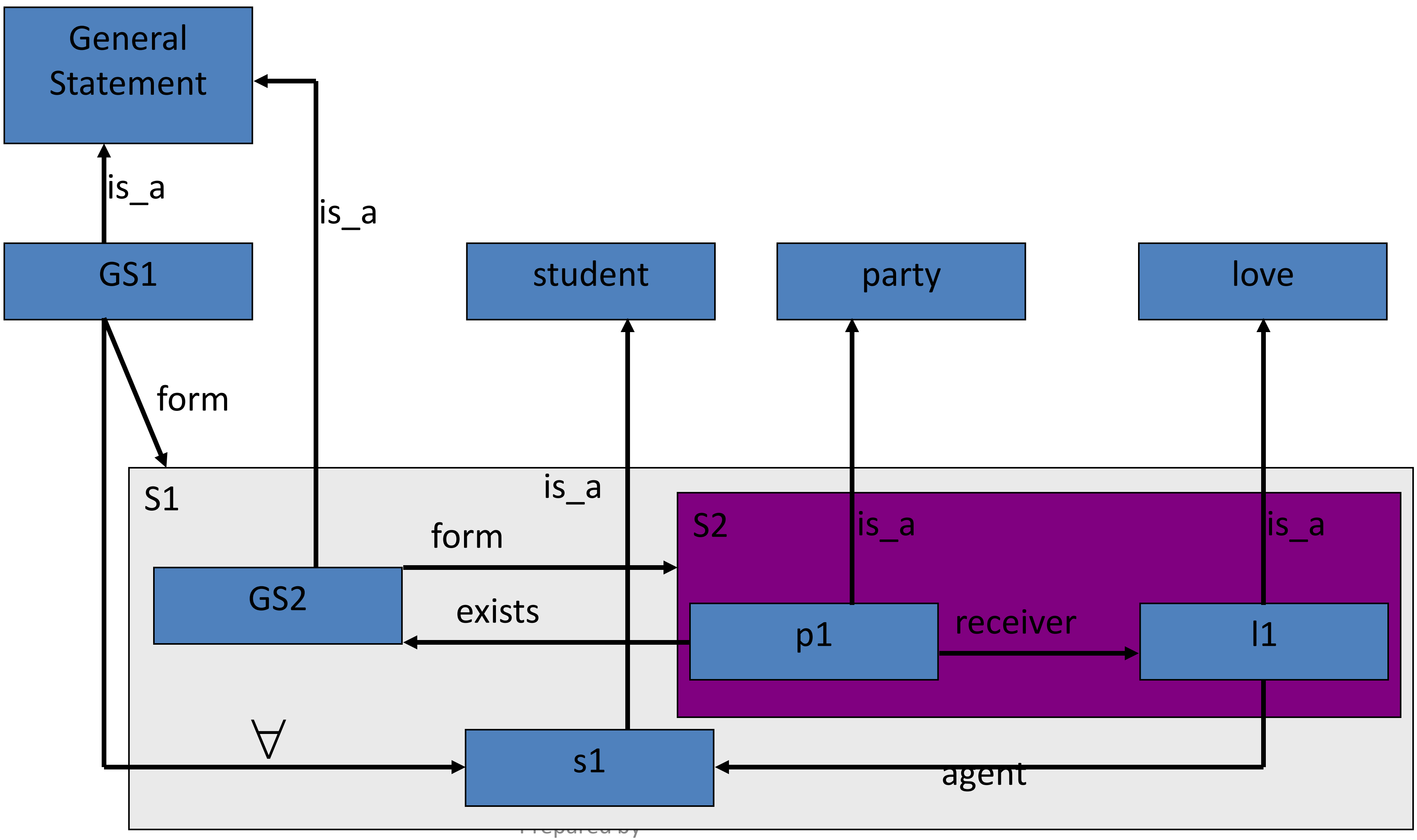
Exercises

- Try to represent the following two sentences into the appropriate semantic network diagram:
  - "John believes that pizza is tasty"
  - "Every student loves to party“
  - John gave Mary the book

Solution 1: "John believes that pizza is tasty"

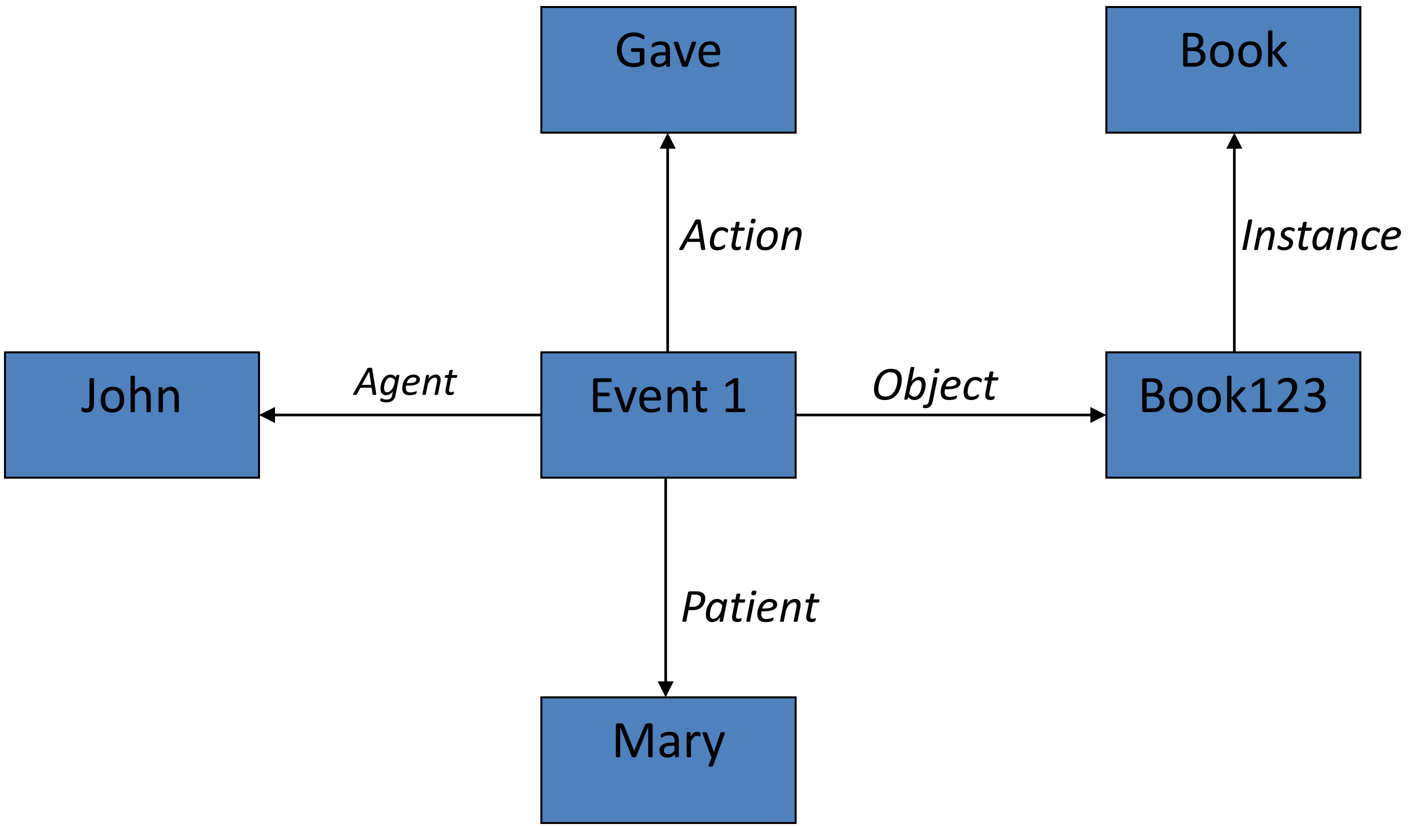


Solution 2: "Every student loves to party"



Solution 3

- John gave Mary the book



Inference in a Semantic Net

Basic inference mechanism: *follow links between nodes.*

Two methods to do this:

Intersection search

-- the notion that *spreading activation* out of two nodes and finding their intersection finds relationships among objects. This is achieved by assigning a special tag to each visited node.

Many advantages including entity-based organisation and fast parallel implementation. However very structured questions need highly structured networks.

Inheritance

-- the *isa* and *instance* representation provide a mechanism to implement this.

Inheritance also provides a means of dealing with *default reasoning*. *E.g.* we could represent:

- Emus are birds.
- Typically birds fly and have wings.
- Emus run.

in the following Semantic net:

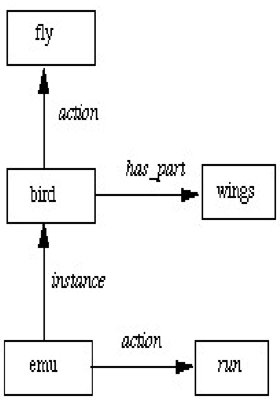
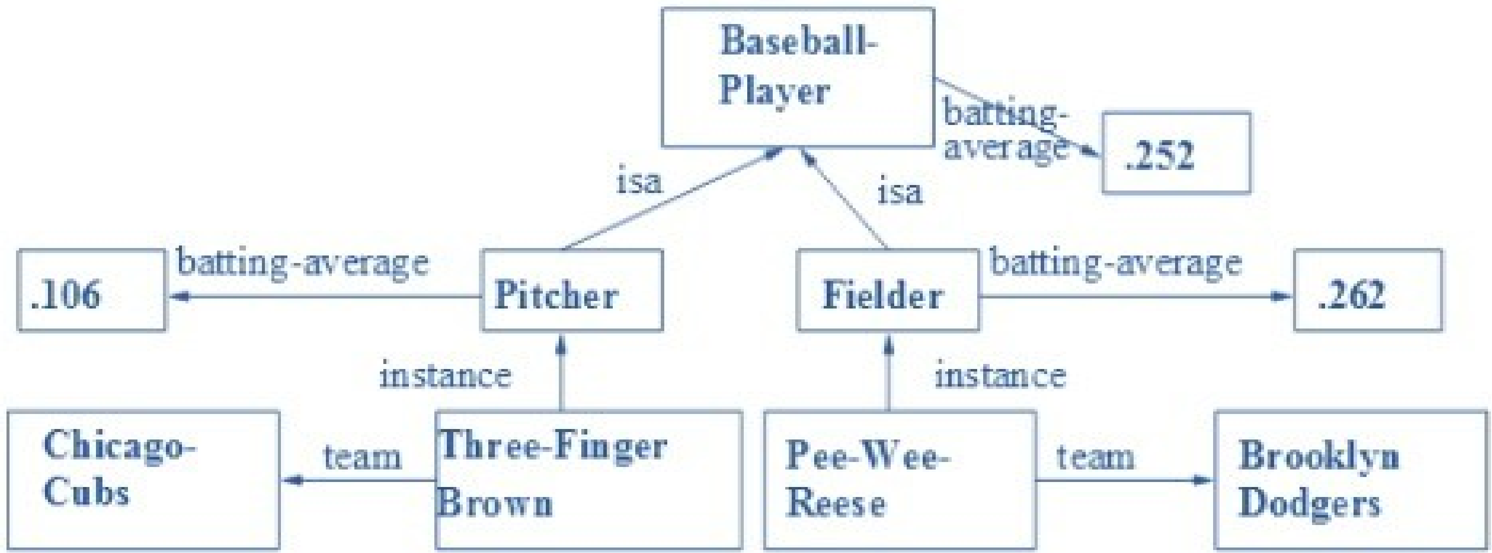


Fig. 12 A Semantic Network for a Default Reasoning

Example of INTERSECTION SEARCH

Question: "What is the relation between Chicago cubs and Brooklyn Dodgers?"



Answer: "They are both teams of baseball players."