# Knowledge Representation & Reasoning

(CSCA-203)

## Lecture Week 6/1: Semantic Network


Farhad Muhammad Riaz

National University of Modern Languages

# Semantic Networks

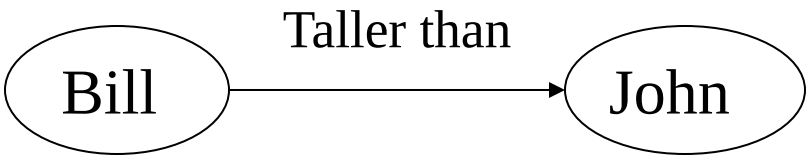
- A Semantic Network (SN) is a simple notation scheme for logical knowledge representation.
- A SN consists of a *concepts* and *relations* between concepts.
- Representing a SN with a directed graph :
  - **Vertices** : denote concepts.
  - **Edges** : represent relation between concepts.
- The graphical depiction associated with a SN is a significant reason for their popularity.

# Semantic Networks

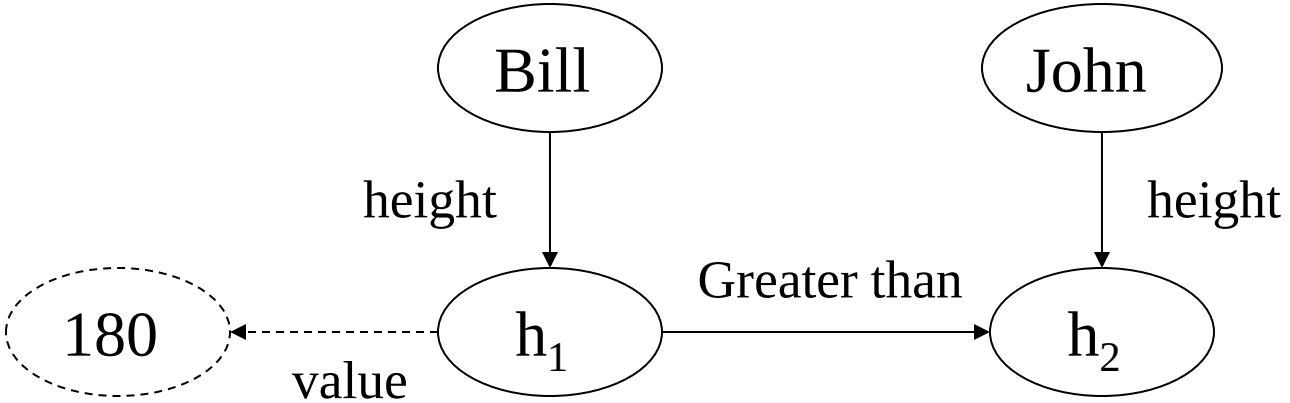
- Consists of nodes and arcs.
- Nodes represents objects.
- Arcs represents relationships between the objects.
- Relationships:
  - is-a
  - Instance
  - has/has-a
  - Others

# Semantic Networks
## Example (1)

- "Bill is taller than John ."
  - Non appropriate scheme :

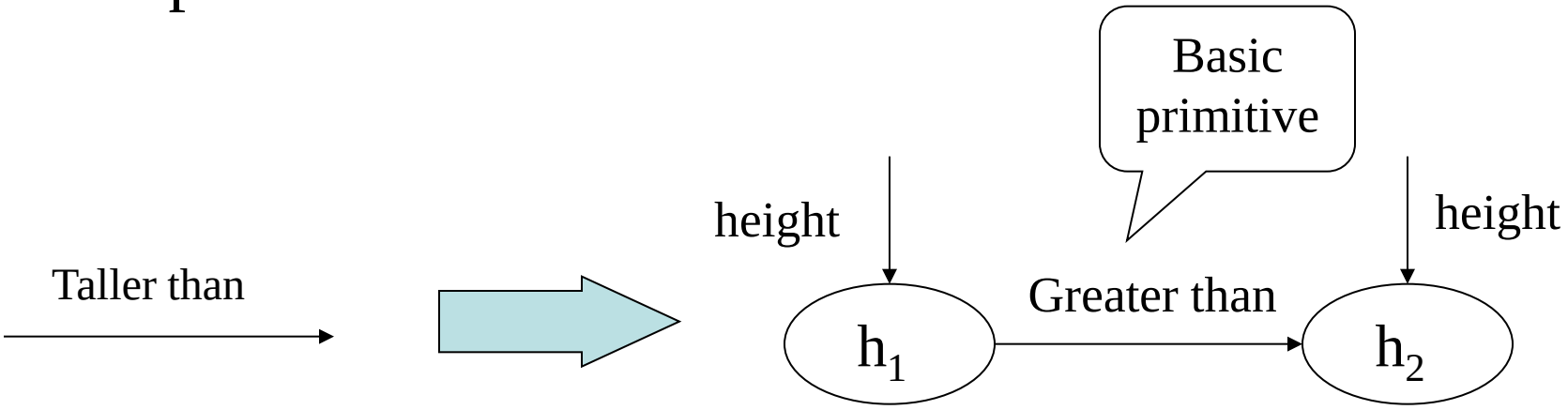



- Appropriate scheme :



# Semantic Networks
## Relations

- For an appropriate scheme:
  - Draw relations on the basic of primitives.
  - Represent complicated relations with this primitives.

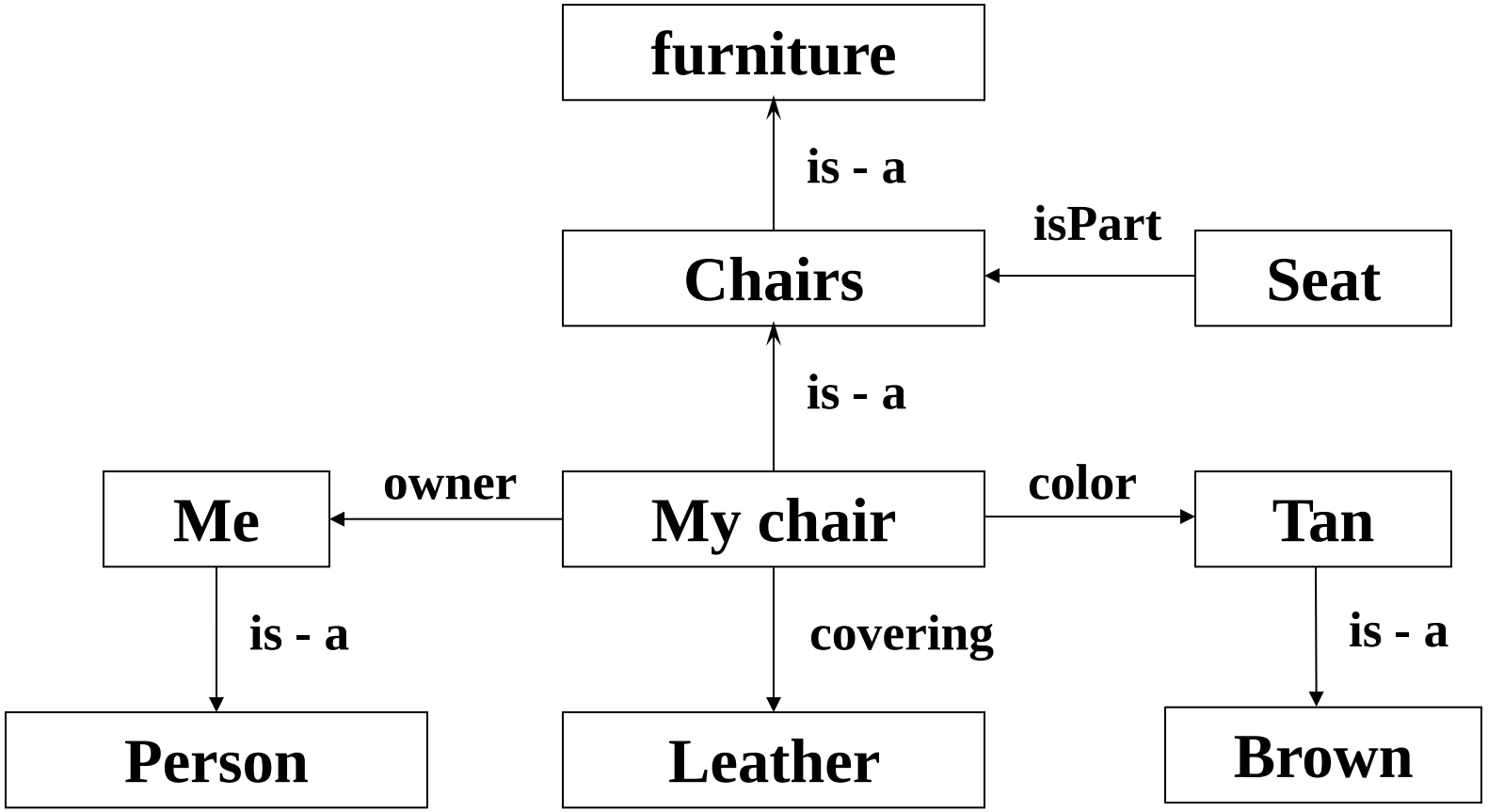


# Semantic Networks
## Relations

- The ISA (is-a) relation is often used to link instances to classes, classes to superclasses.
- Some links (e.g. isPart) are inherited along ISA paths.
- The semantics of a SN can be relatively very formal or informal.
  - often defined at the implementation level

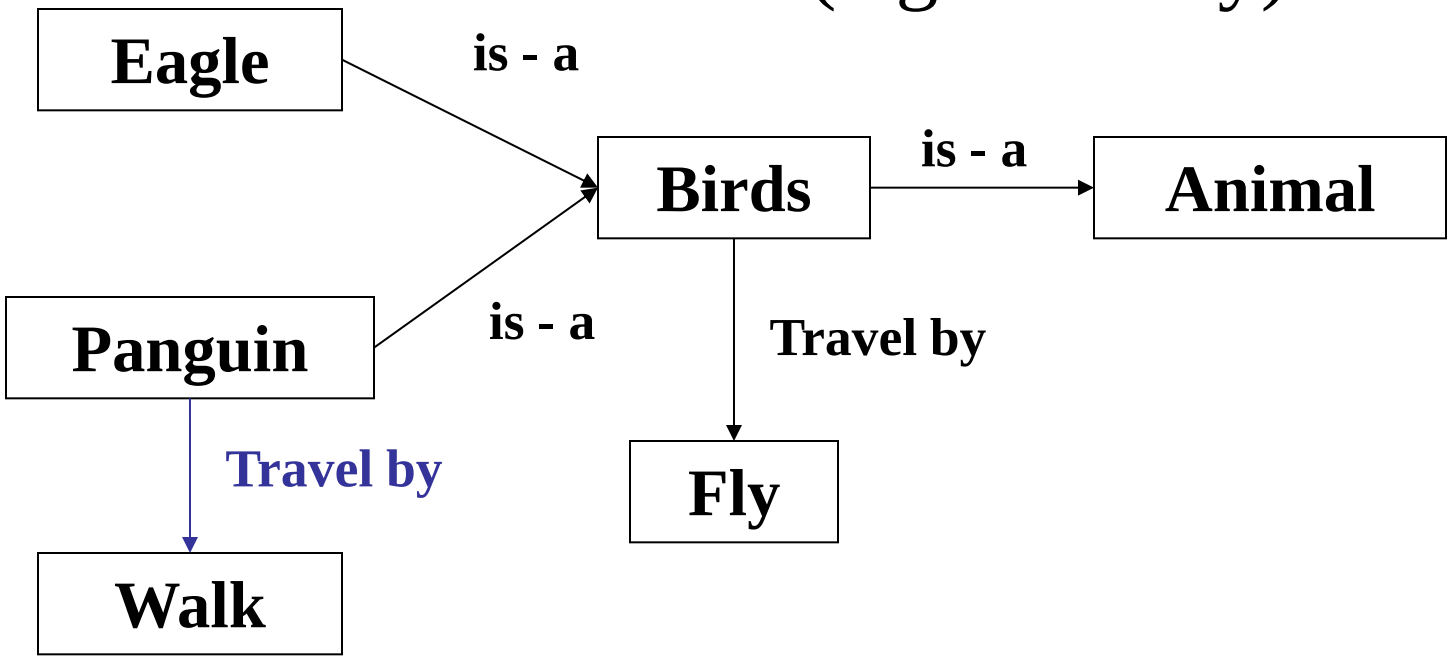
# Semantic Networks

## Relations



# Semantic Networks
## Relations

- Some times we had to override a relation for an inherited node (e.g travel by).

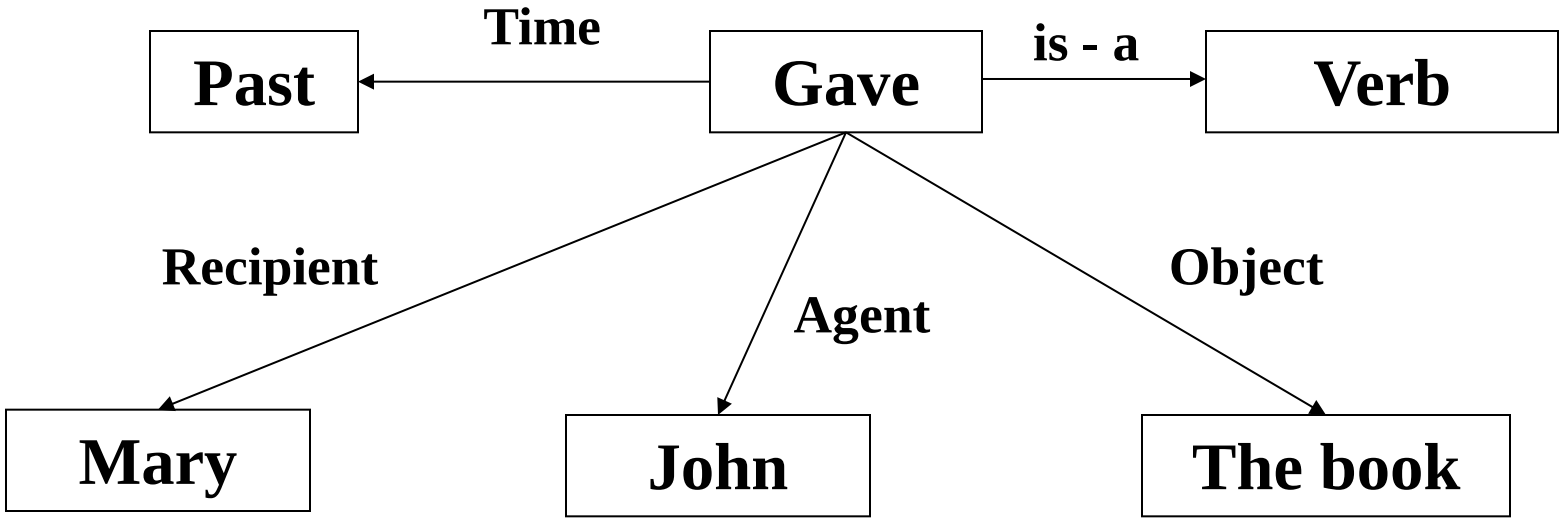


# Semantic Networks
## Reification

- Non-binary relationships can be represented by "turning the relationship into an object"
- This is an example of what logicians call "reification".
  - consider an abstract concept to be real.
  - We might want to represent the generic *give* event as a relation involving four things: an *agent*, a *recipient*, an *object* and an *activation time*.

# Semantic Networks
## Reification

- Consider this : “John gave Mary the book.”
  - Abstract concept (gave) => real.



# Semantic Networks

## Example (2)

- Family relationships.
- Primitives :
  - father, mother, brother, sister, son, daughter.
- More complicated relations representing with primitives:
  - aunt ( man ) : sister ( father ( man ))
  - causion ( man ) : son ( brother ( mother ( man )))
  - etc .

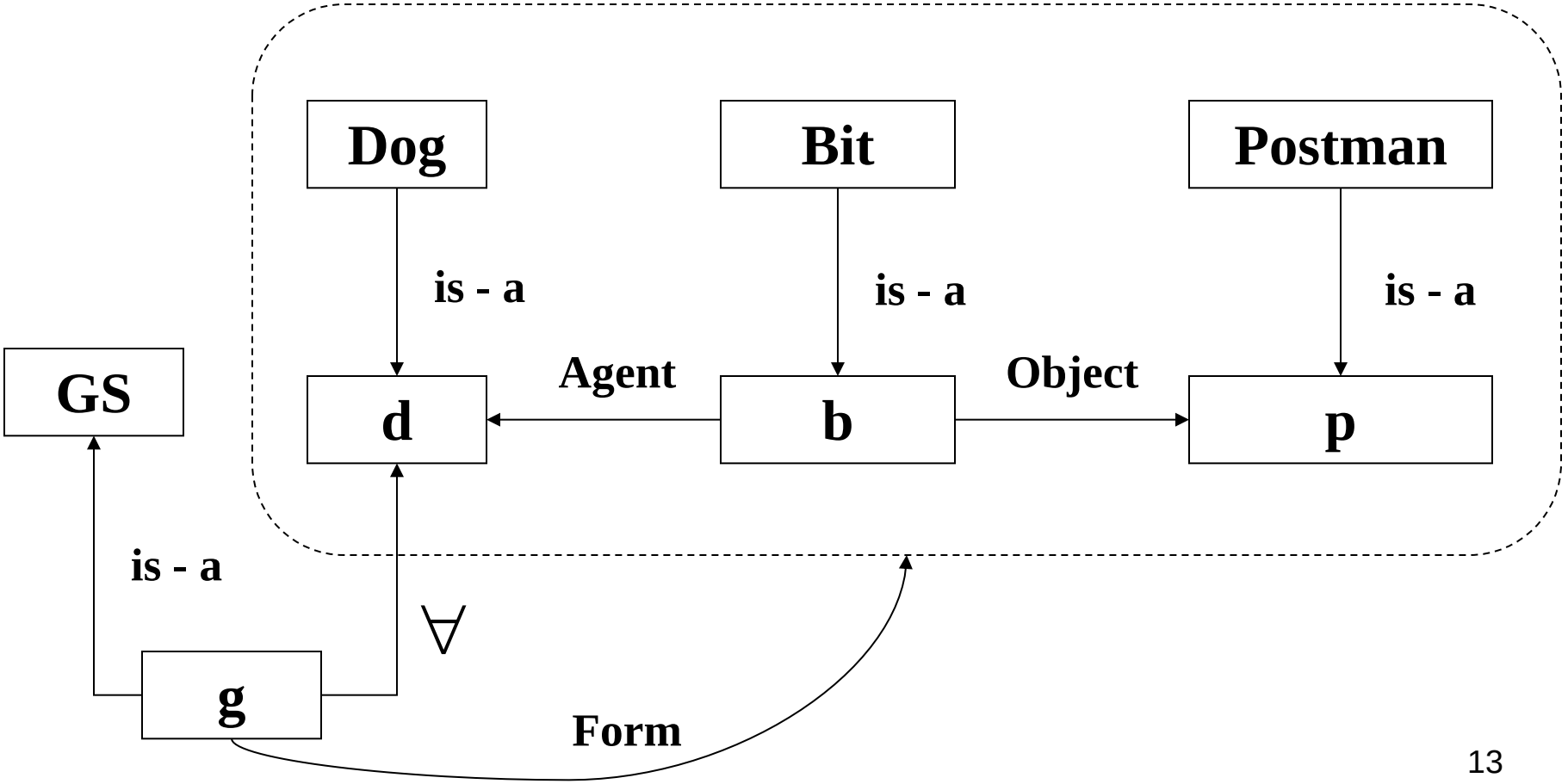
# Semantic Networks

## Example (3)

- “Every dog has bitten a postman.”
- Is equal to :
  - $\forall X\ (\ dog(X) \longrightarrow \exists Y\ (\ postman(Y)\ \&\ bitten(X, Y)))$
- Represent SN for one *(dog, postman)*.
- Quantify the represented SN.
- GS is the set of generilized statements that has been quanified.

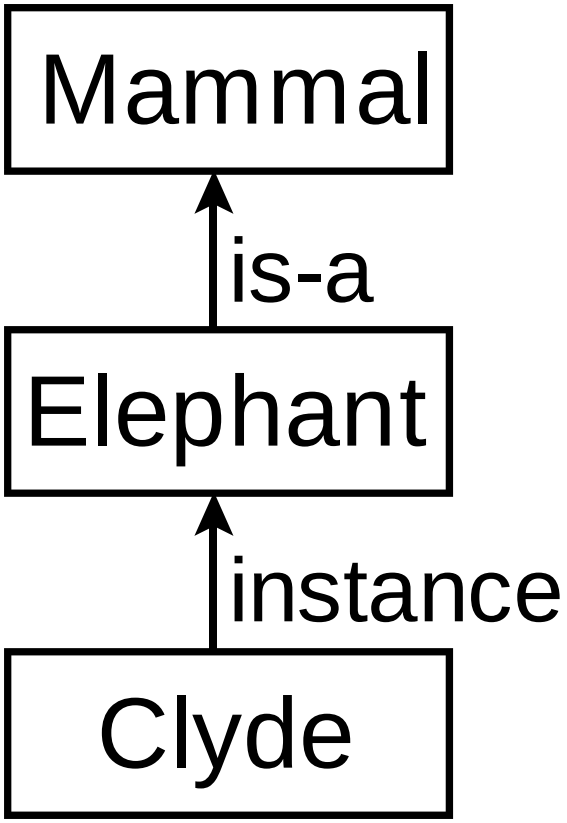
# Semantic Networks

## Example (3)

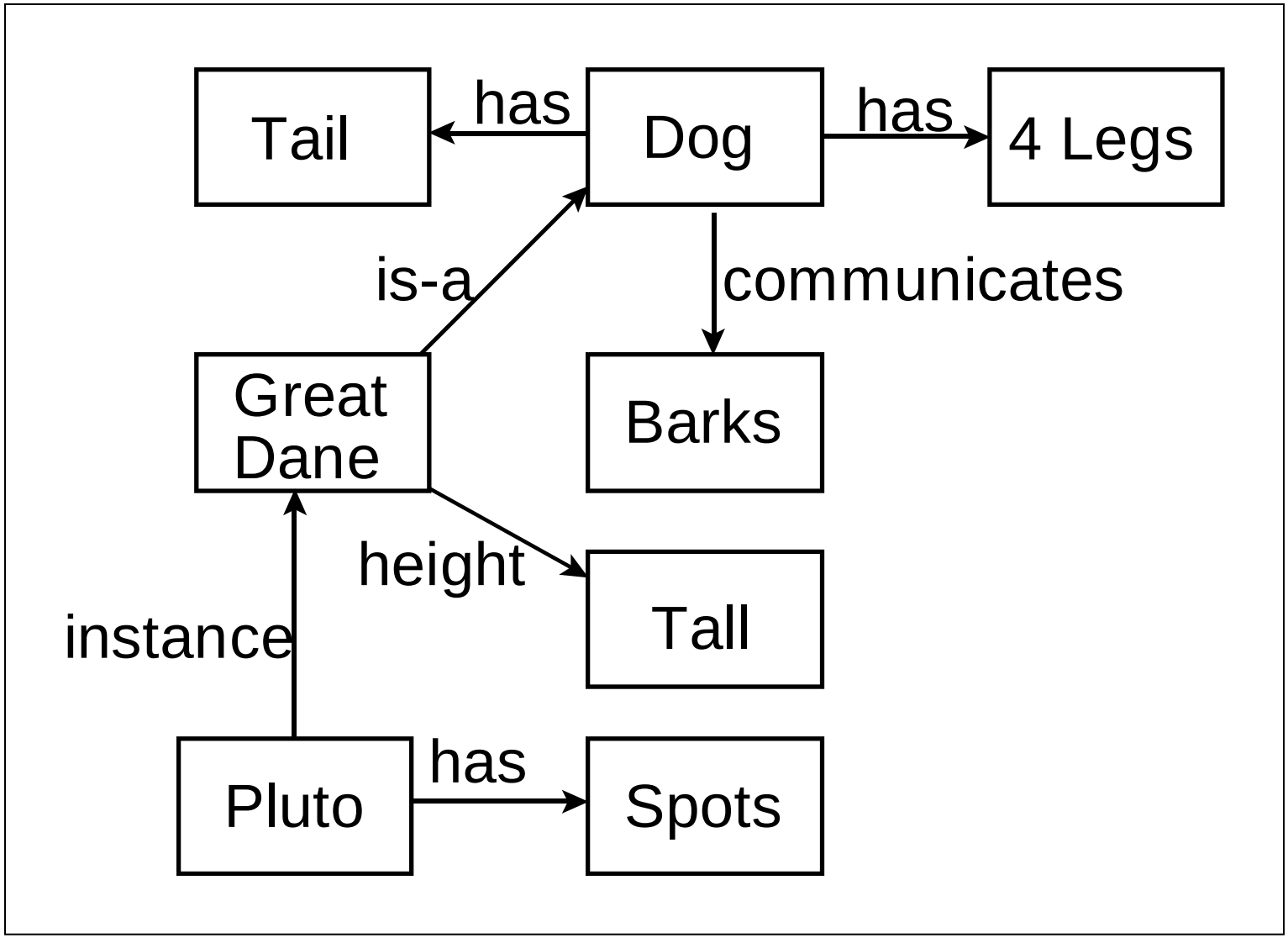


# Example 4

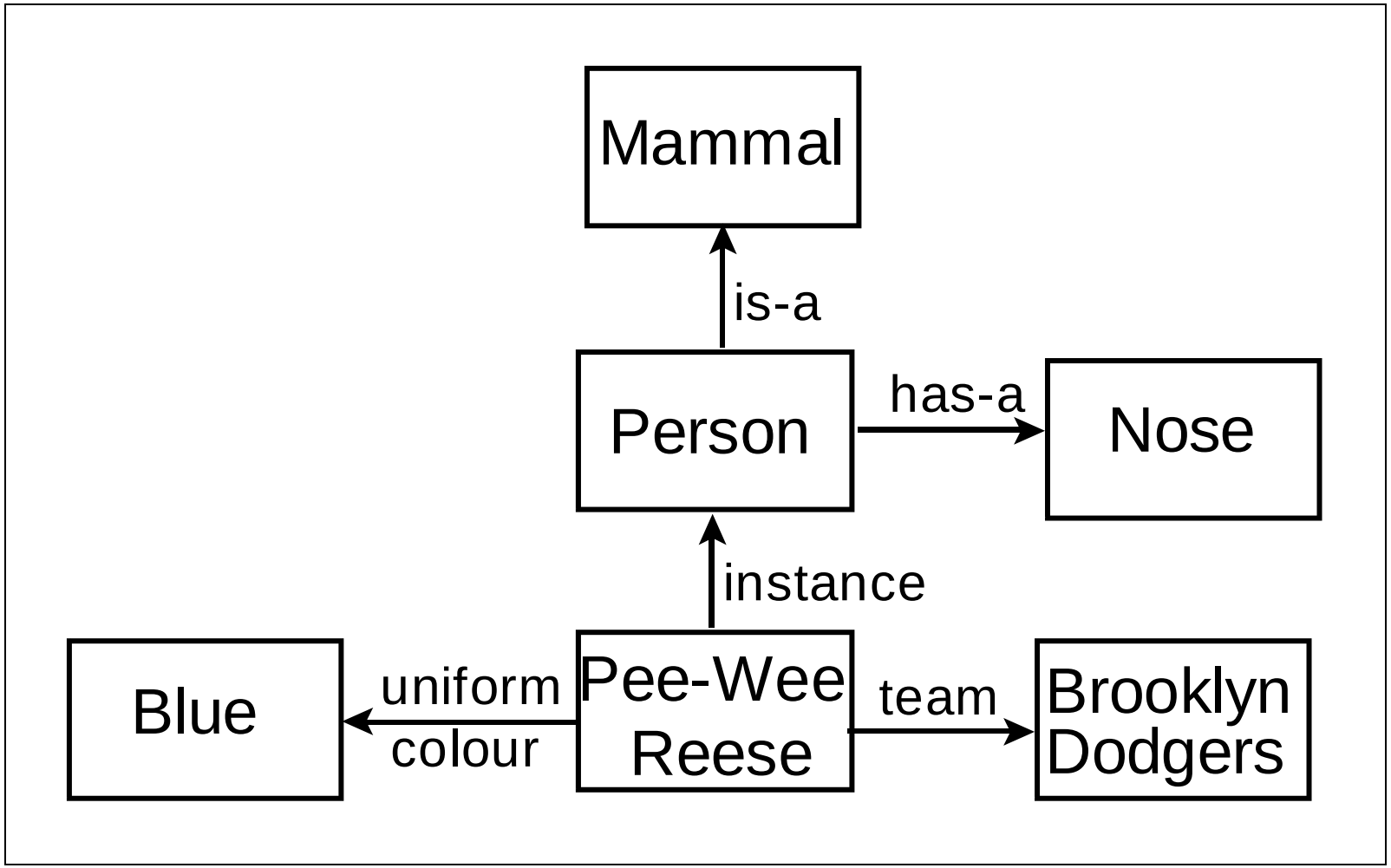
Clyde is an elephant.



# Example 5


Tail
has
Dog
has
4 Legs
is-a
communicates
Great Dane
Barks
height
Tall
instance
Pluto
has
Spots

# Example 6

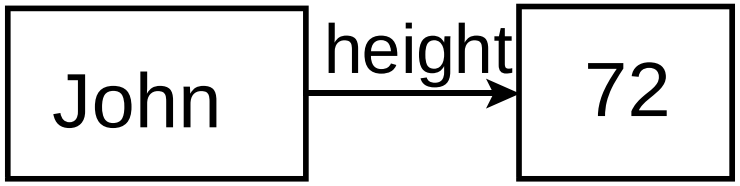

Mammal
is-a
Person
has-a
Nose
instance
Blue
uniform
colour
Pee-Wee
Reese
team
Brooklyn
Dodgers

# Short Question

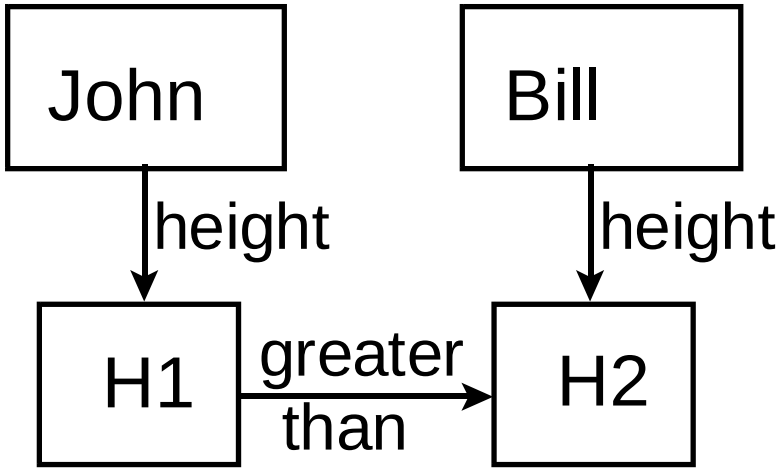
- John’s height is 72.
- John is taller than Bill.
- John gives Mary the book.
- Mary gave the green coloured vase to her favorite cousin.

# Example 7

John's height is 72.

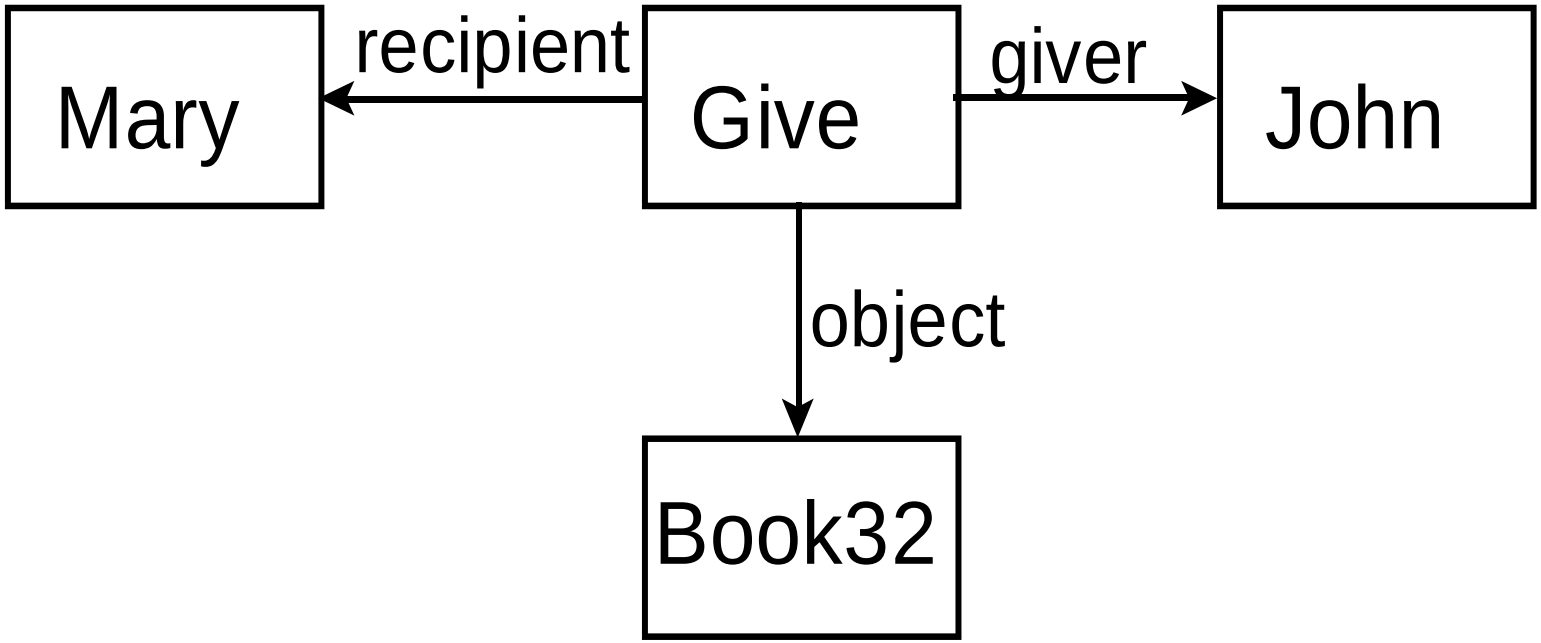



John is taller than Bill.



# Example 8

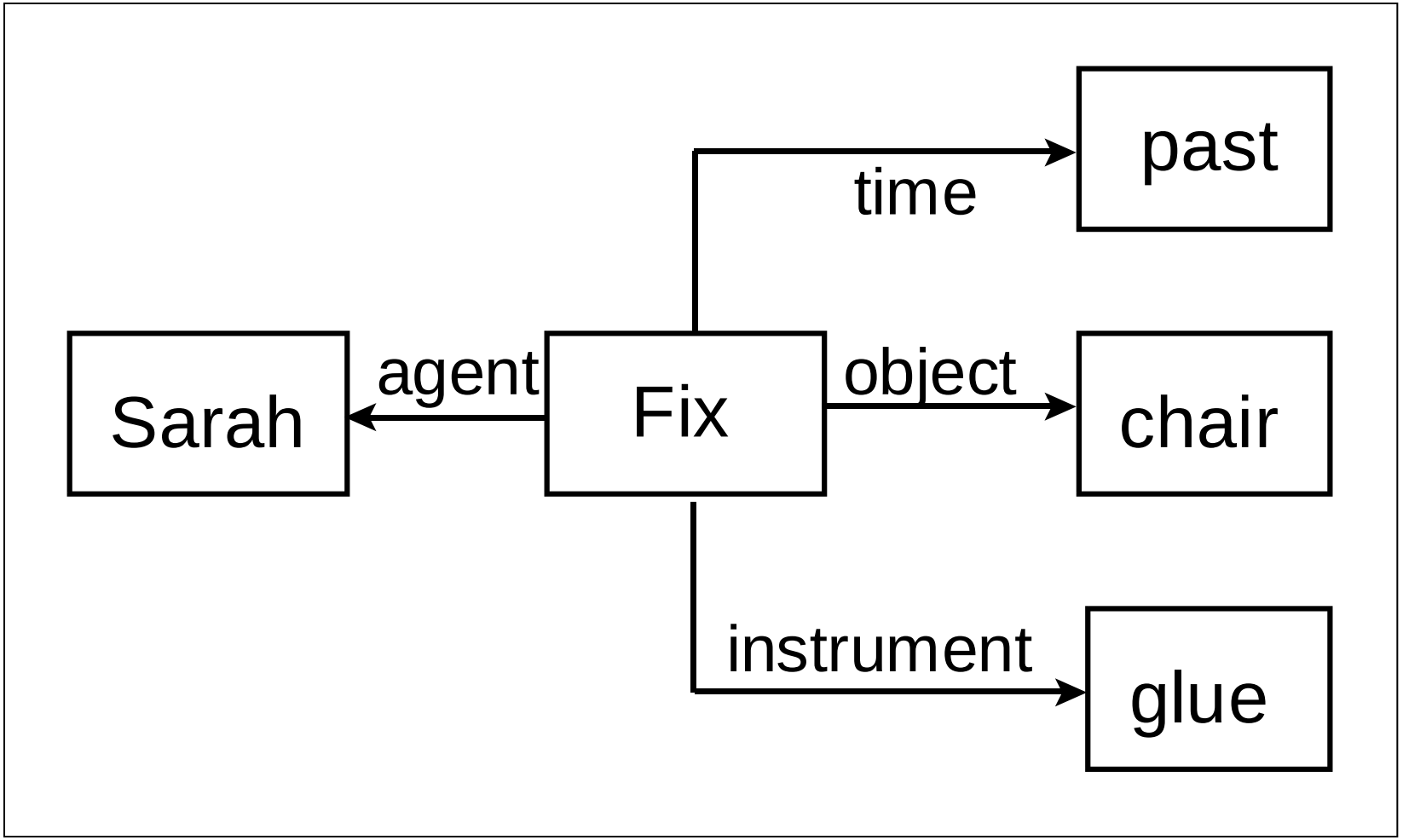
John gives Mary the book.



# Using Case Frames

- Problems with semantic networks
- Attempts to standardize semantic networks led to the development of case frames.
- Each sentence is represented by a case frame.
- Each case frame represents an actions.
- Case frames define case relationships: agent, object, instrument, location and time.

# Example: Case Frame



# Exercises

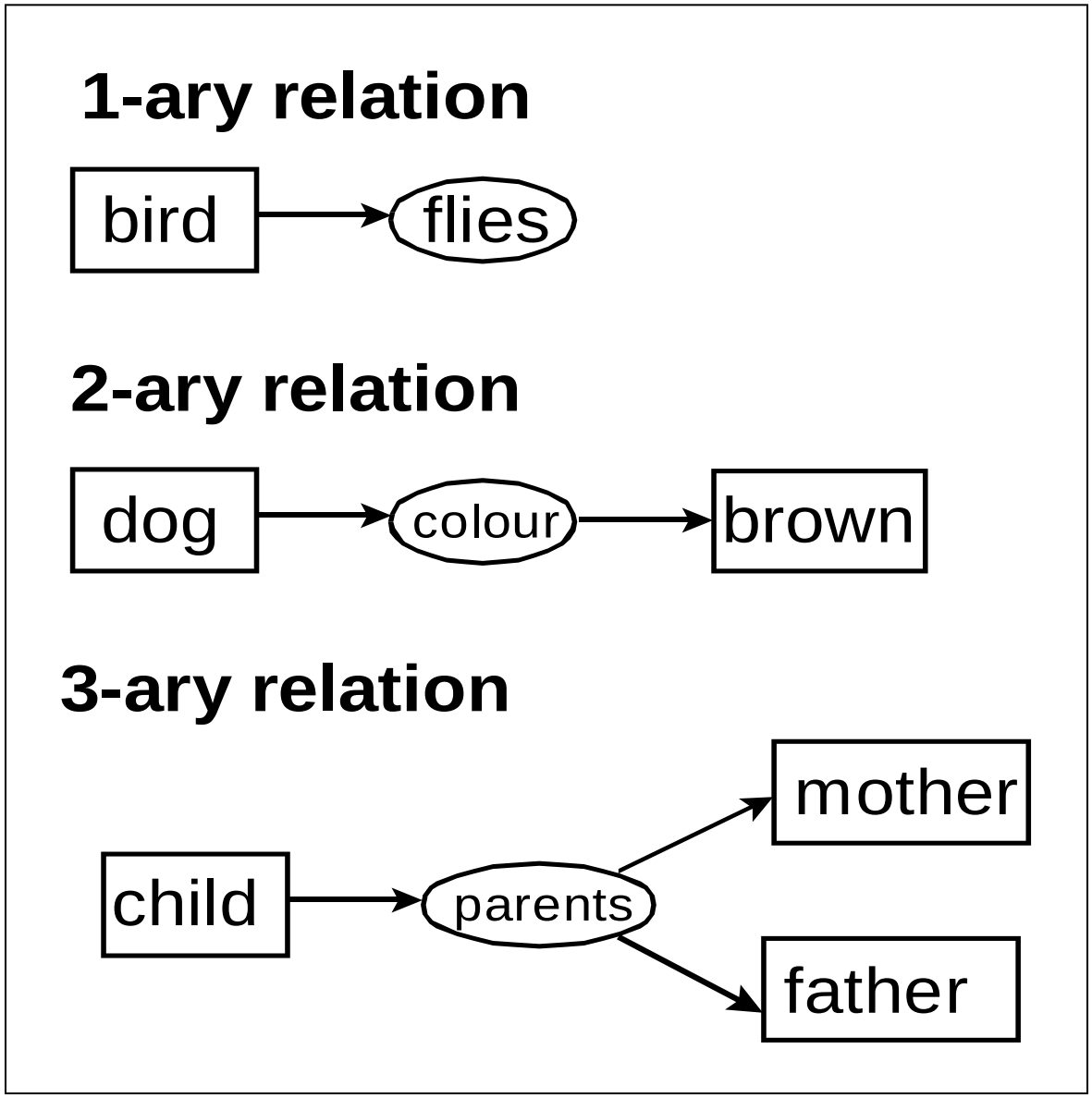
Construct semantic networks for the following statements:

- Pompeian(Marcus), Blacksmith(Marcus).
- Mary gave the green coloured vase to her favorite cousin.
- John went downtown to deposit his money in a bank.

# Conceptual Graphs

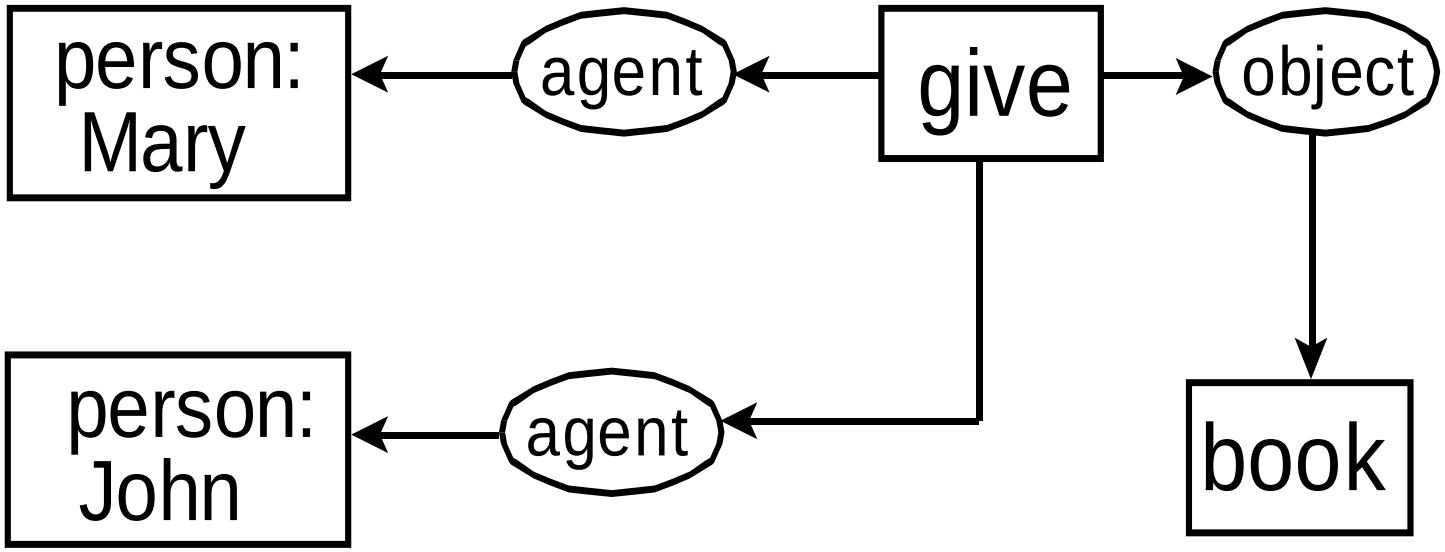
- Is a connected bipartite graph.
- Conceptual relation nodes represent relations between concepts.
- The arcs connecting nodes are not labeled.
- Concepts are represented by boxes.
- Relations are represented by arcs.

# Conceptual Graph Relations



# Example

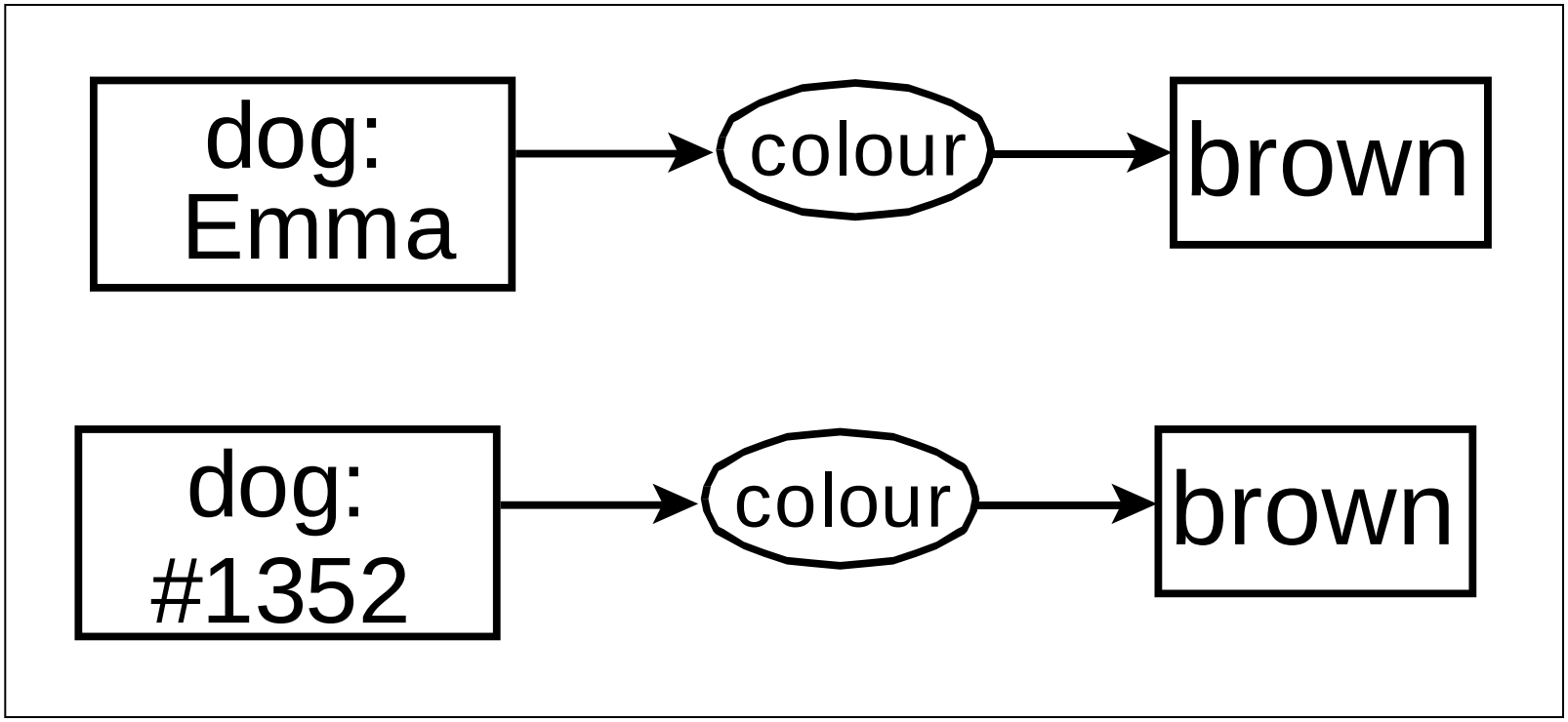
Mary gave John the book.



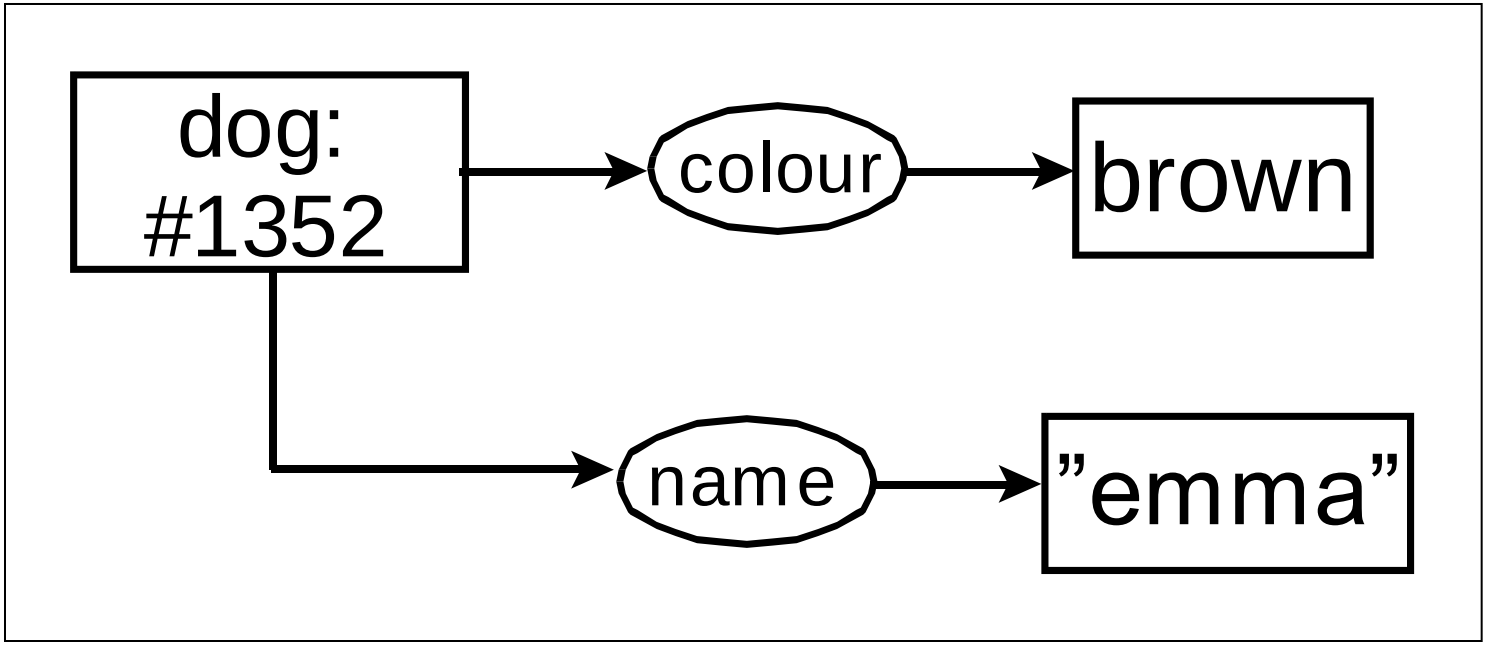
# Unique Markers

- If an individual object is unknown a **unique marker** can be used in place of the name of the object.
- A unique marker is comprised of a hash symbol (#) followed by a number.
- Each object has its own unique marker.

# Example 1: Unique Markers

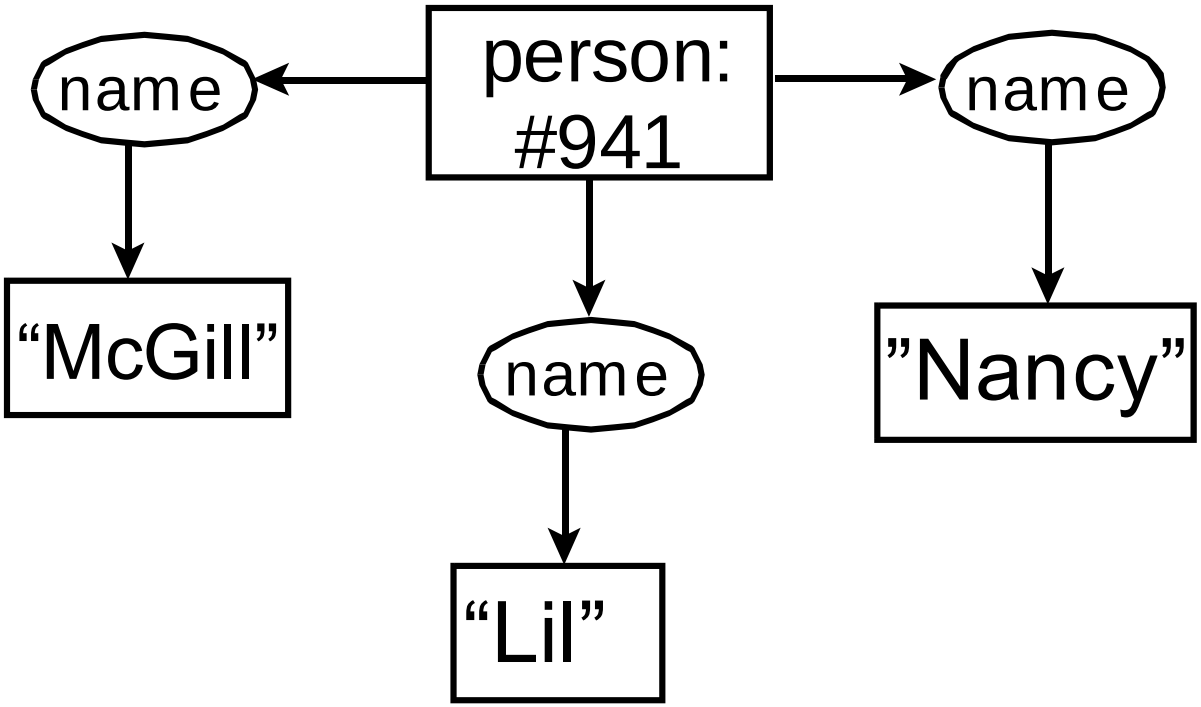


# Example 2: Unique Marker



# Example

Her name was McGill and she called herself Lil, but everyone knew her as Nancy.

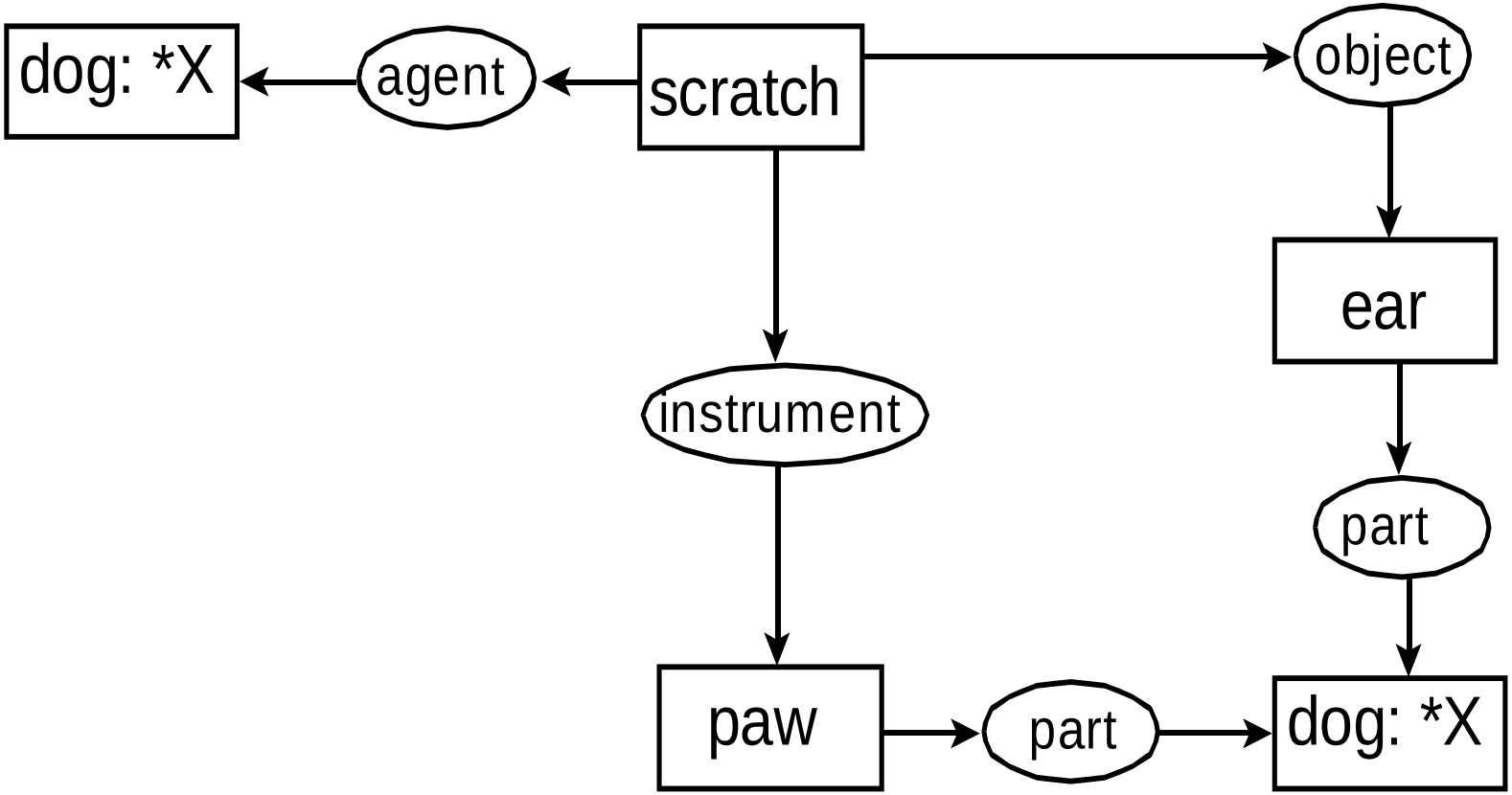


# Generic Markers

- A generic marker is used to represent an unspecified individual of a type.
- A generic marker is represented by an asterisk *.
- Name variables can also be used, e.g., *X to indicate an unspecified individual.

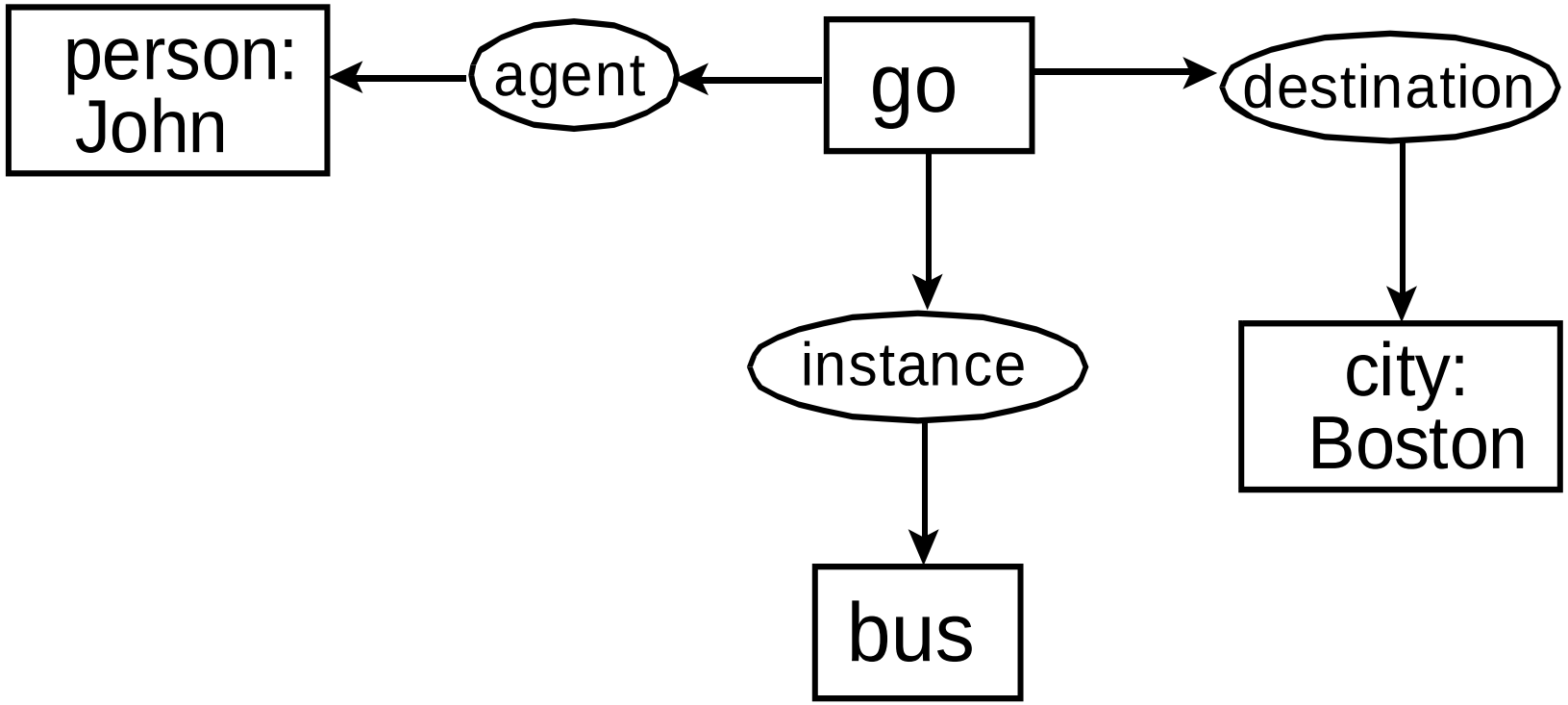
# Example: Generic Marker

The dog is scratching its ear with its paw.



# Display Form

John is going to Boston by bus.



# Linear Form

John is going to Boston by bus.

[Go] –

(Agnt) → [Person: John]

(Dest) → [City: Boston]

(Inst) → [Bus]

# Exercises

Construct conceptual graphs for the following statements:

- Jane gave Tom an ice cream.
- Basketball players are tall.
- Paul cut down the tree with an axe.
- Place all the ingredients in a bowl and mix thoroughly.

?