

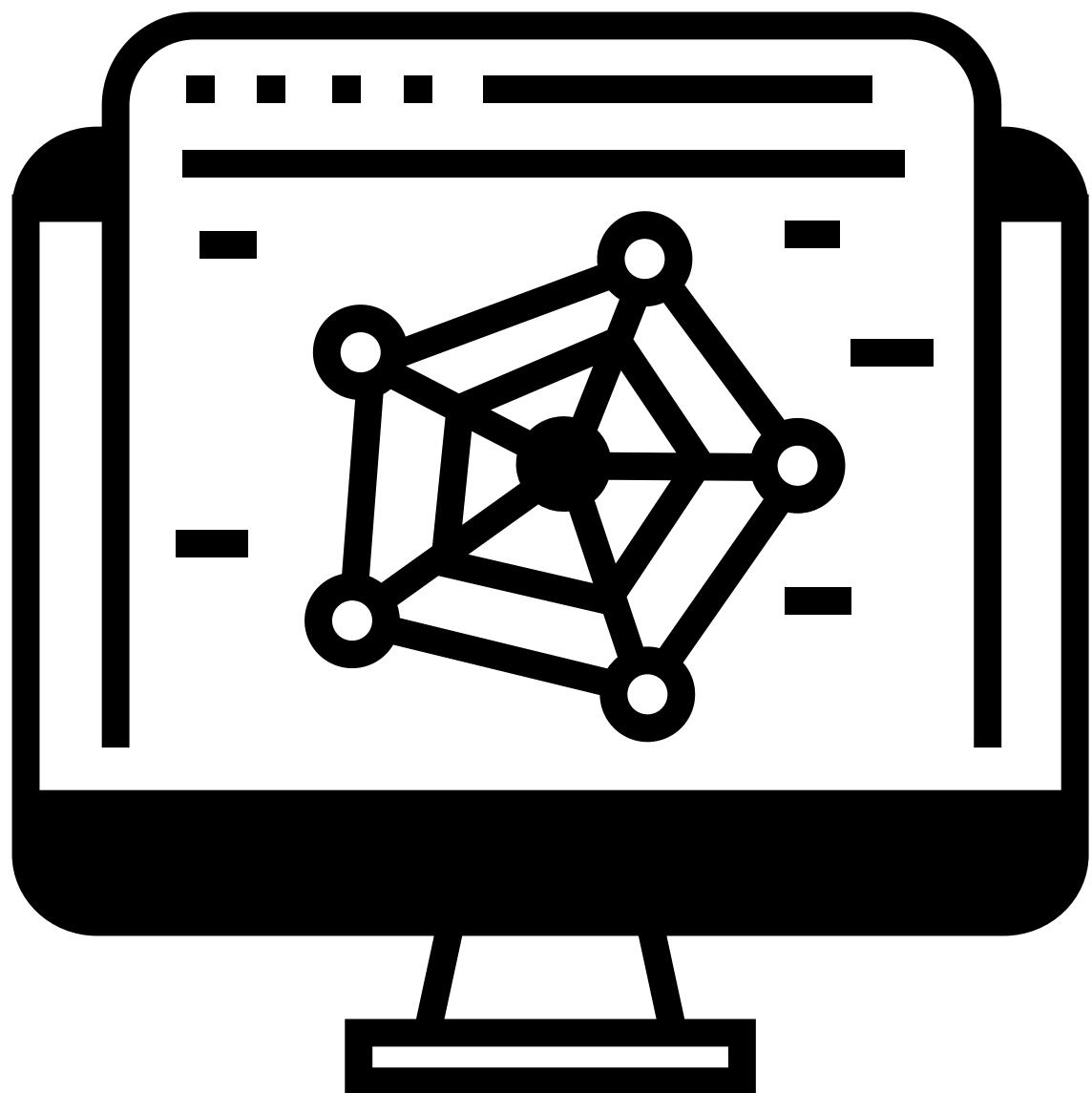
ARTIFICIAL INTELLIGENCE

BACS2003|BACS3074|BMCS2003

CHAPTER 5 KNOWLEDGE REPRESENTATION

1. Semantic Network
2. Conceptual Graph
3. And/Or Graph
4. Frames

OUTCOMES



WHAT IS KNOWLEDGE REPRESENTATION



by MJ Johnson · Cited by 7 — In this context, **book** must be redefined to incorporate the context of new social technology. Key Words: Authors, Book, Publishing, social media. What is a **Book**?
20 pages

Jane Friedman
<https://www.janefriedman.com> › Blog

[Start Here: How to Write a Book Proposal + ... - Jane Friedman](#)

28 May 2017 — Book proposals are used to sell nonfiction books to publishers. A book proposal argues why your **book** (idea) is salable and marketable in ...

ThoughtCo
<https://www.thoughtco.com> › Classic Literature › Terms

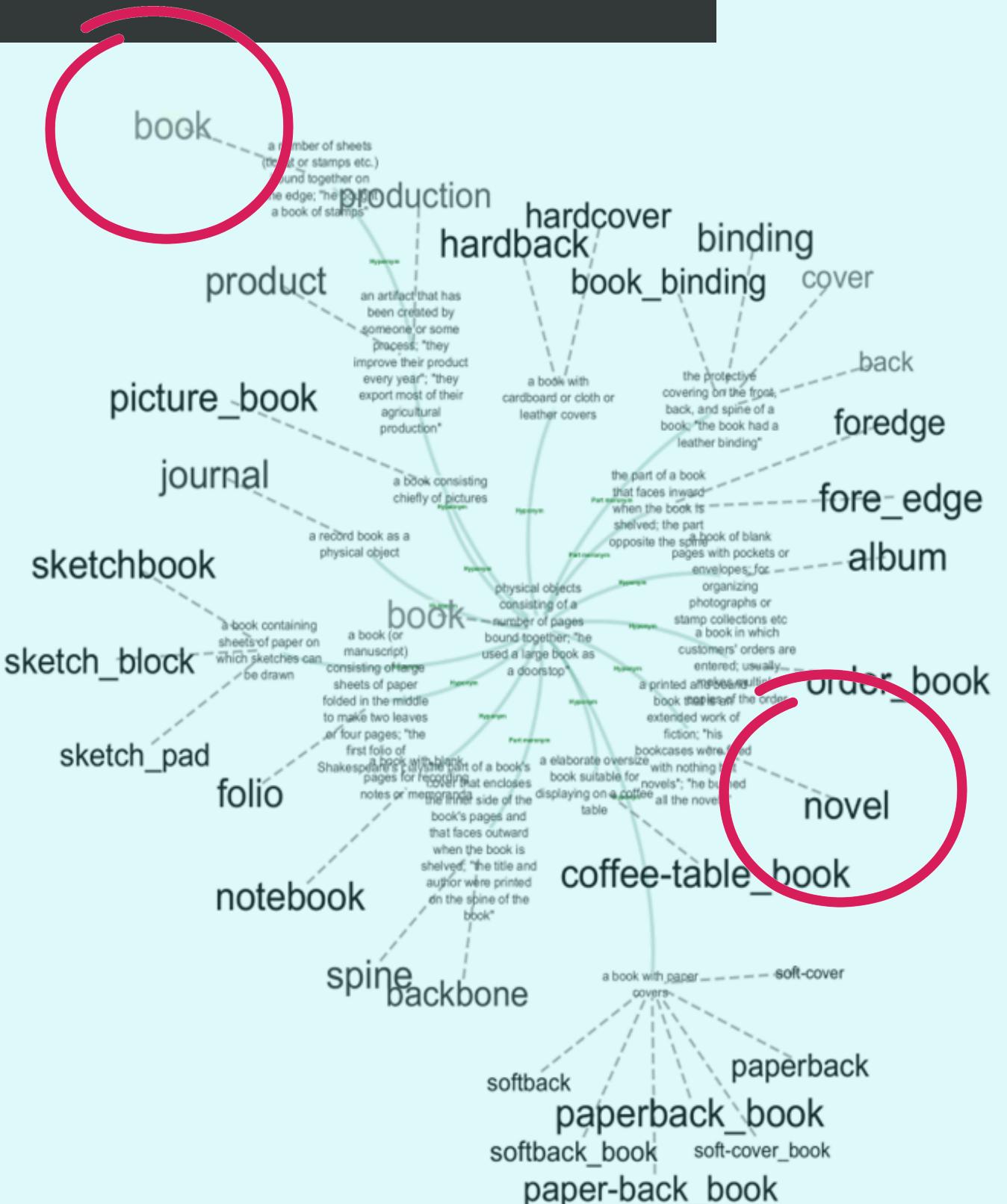
[What Is a Novel? Definition and Characteristics - ThoughtCo](#)

2 May 2019 — A **novel** is a narrative work of prose fiction that tells a story about specific human experiences over a considerable length.

G2
<https://learn.g2.com> › what-is-an-ebook

[What is an eBook? Understanding Why They Work ... - Learn G2](#)

19 Jul 2018 — Pretty straightforward. An electronic **book**; an eBook. But here's the thing: If an eBook is simply a book in a digital form that, technically, ...



(a) Something about *book*.

WHAT IS KNOWLEDGE REPRESENTATION

Google

half an hour

X



- a point in time thirty minutes after any full hour of the clock.
plural noun: **half-hours**; noun: **half hour**; plural noun: **half hours**
"the library clock struck the half hour"

Feedback

More definitions ▾

People also ask

Is half an hour 30 minutes?

Is it half-hour or half an hour?

How do you say 1.5 hours in English?

What is the mean of half an hour?

Feedback

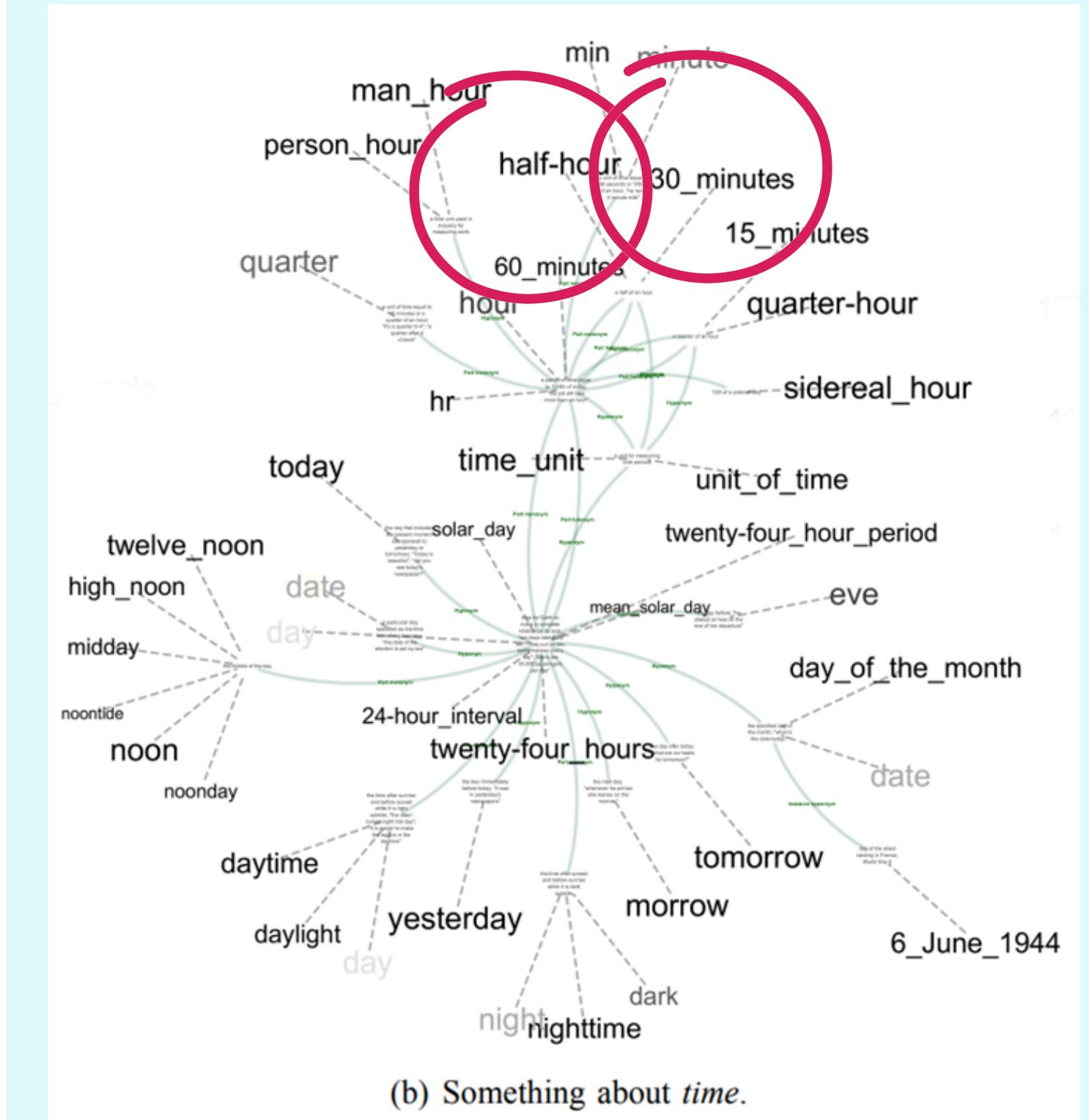


Merriam-Webster

<https://www.merriam-webster.com/dictionary/half...> ::

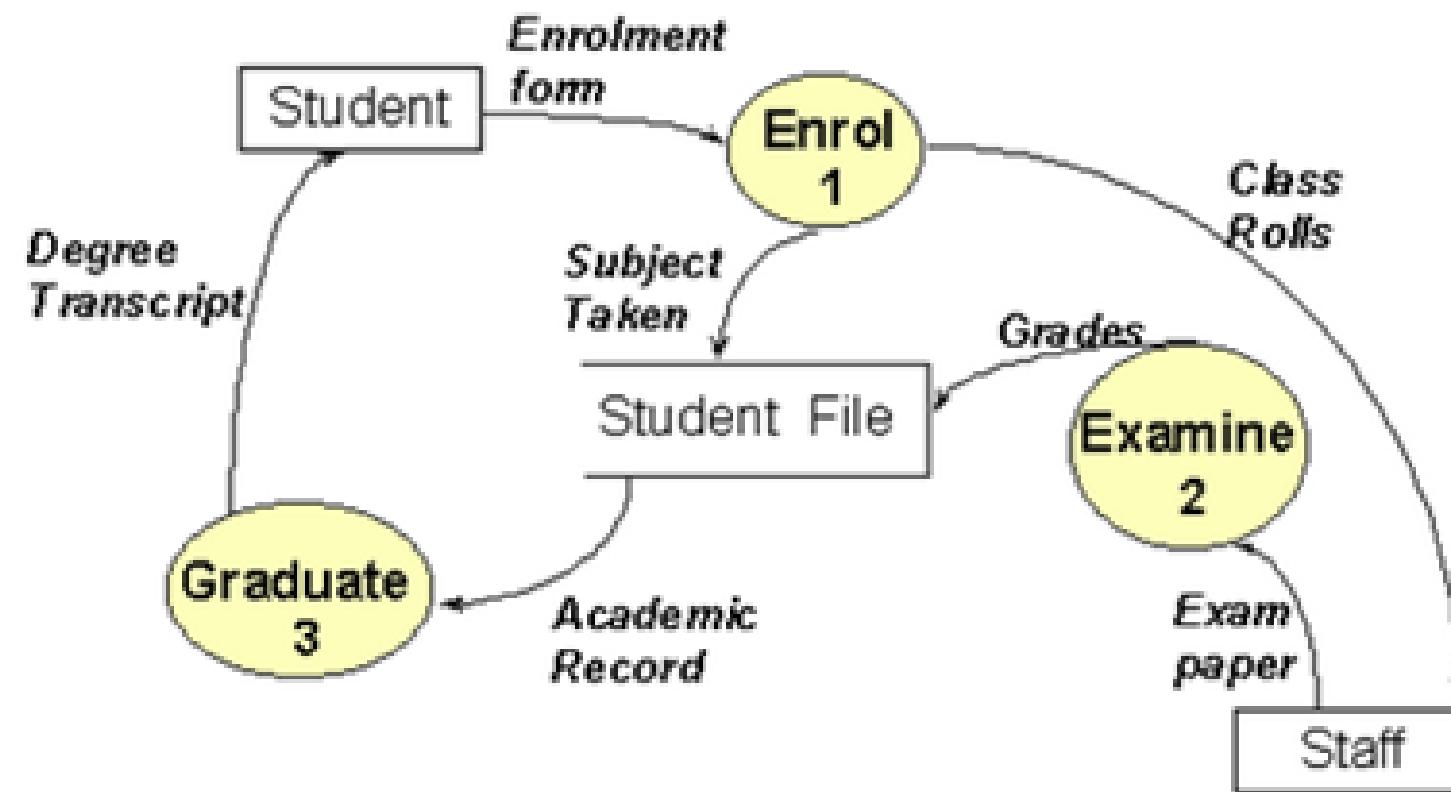
[Half an hour Definition & Meaning - Merriam-Webster](#)

The meaning of HALF AN HOUR is 30 minutes. How to use half an hour in a sentence.

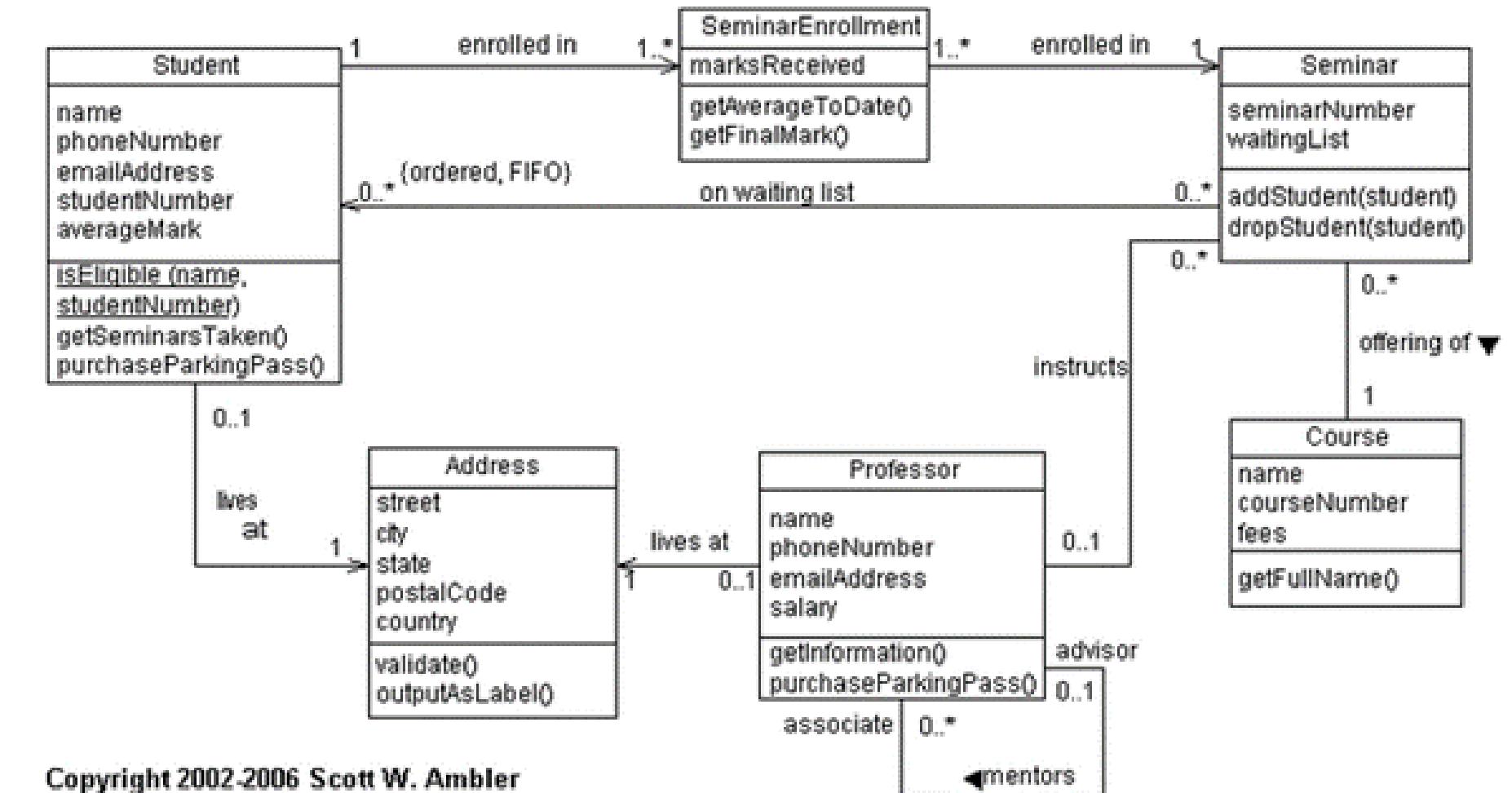


REPRESENTATION TOOLS

DFD Example (Student Administration)



SDLC – DFD

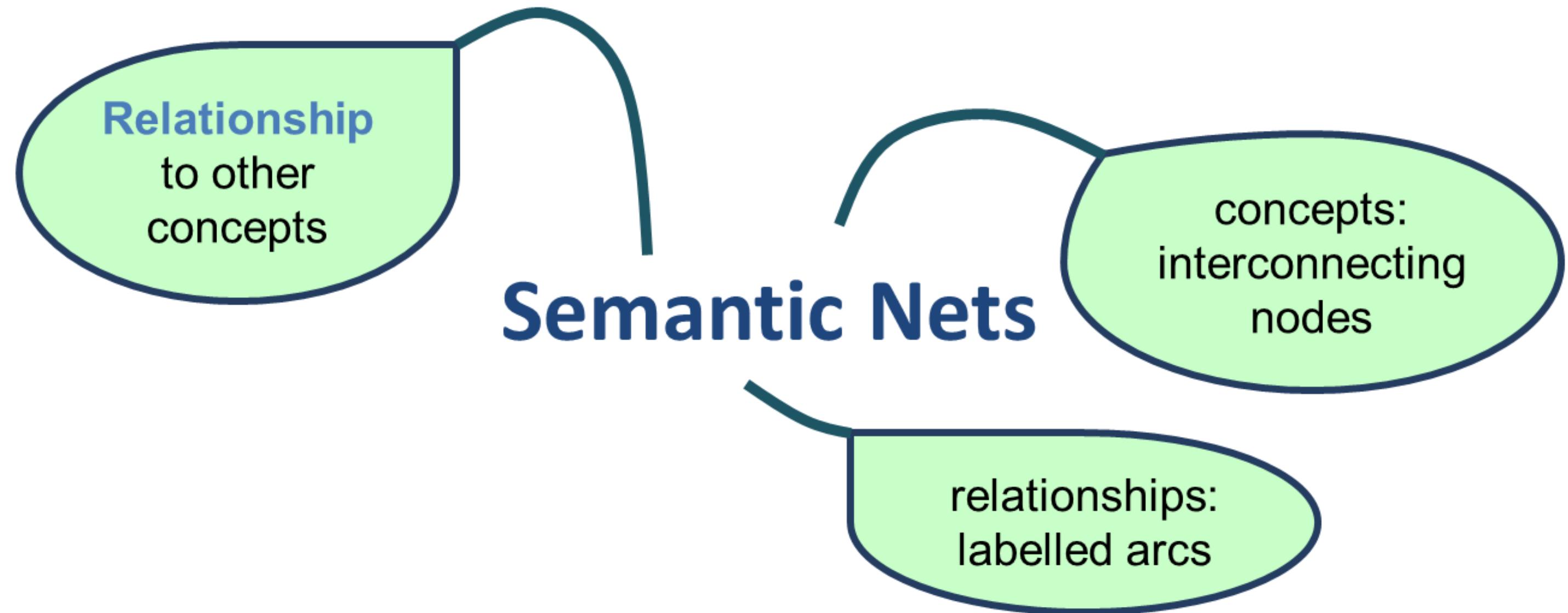


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OO – UML

To represent concepts, use semantic nets, ontology, frames, etc

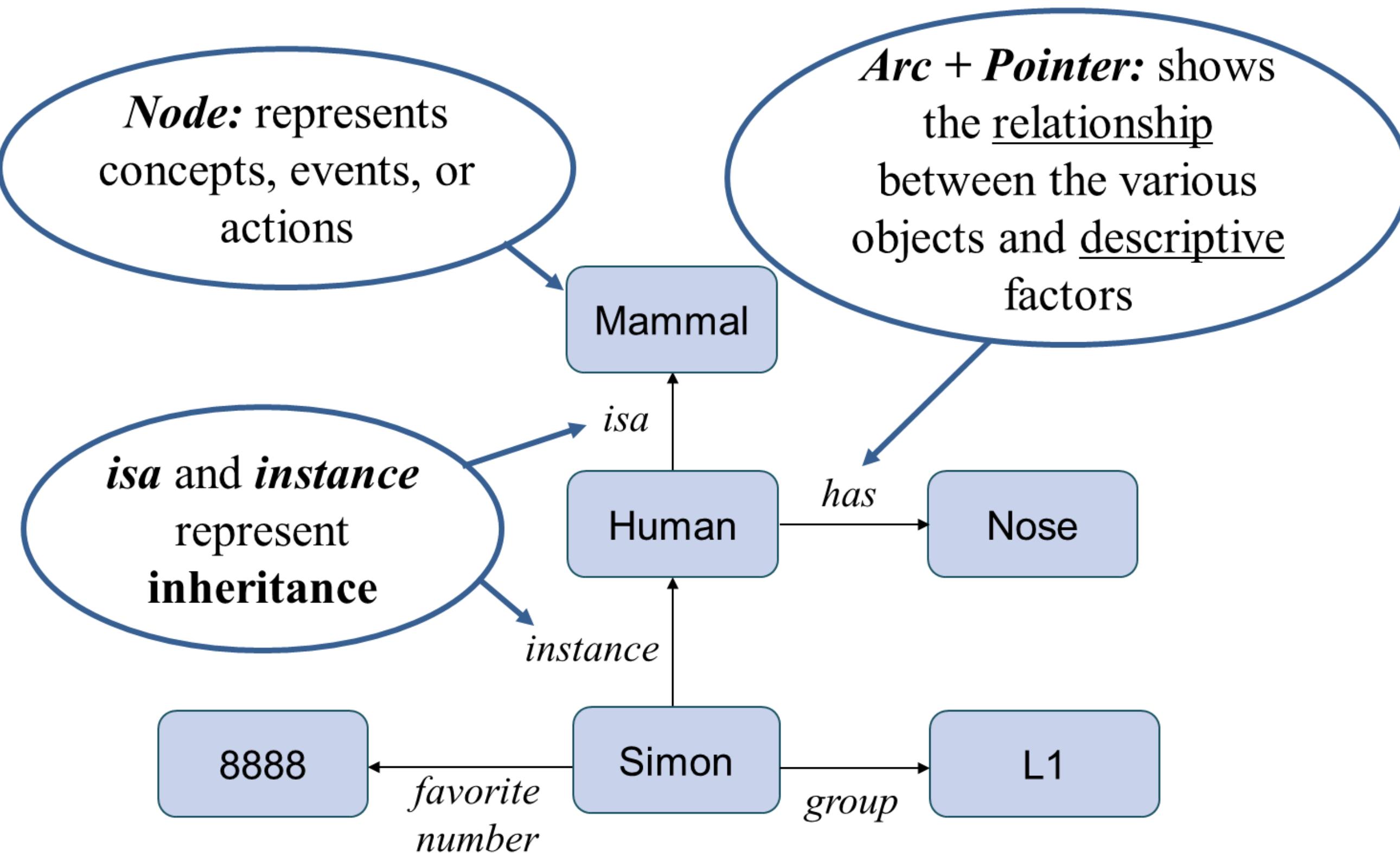
SEMANTIC NETS



- The meaning of a concept comes from its relationship to other concepts
- Associationist theories: define the meaning of an object in terms of a network of associations with other objects
- The information is stored by interconnecting nodes with labelled arcs

SYNTAX

SEMANTIC NETS



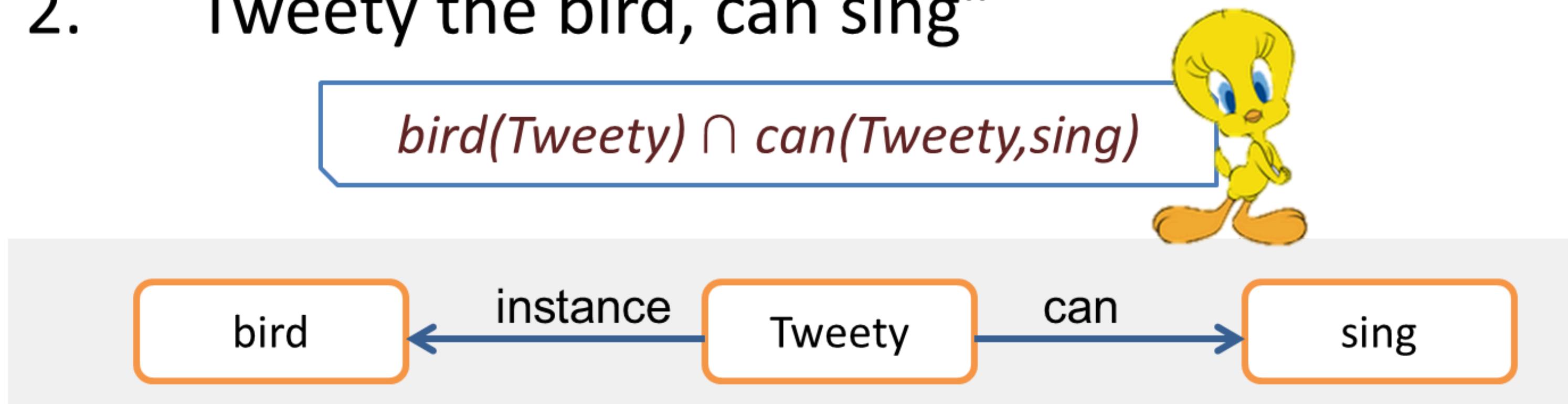
EXAMPLE

SEMANTIC NETS

1. “ShinChan is 5 years old”

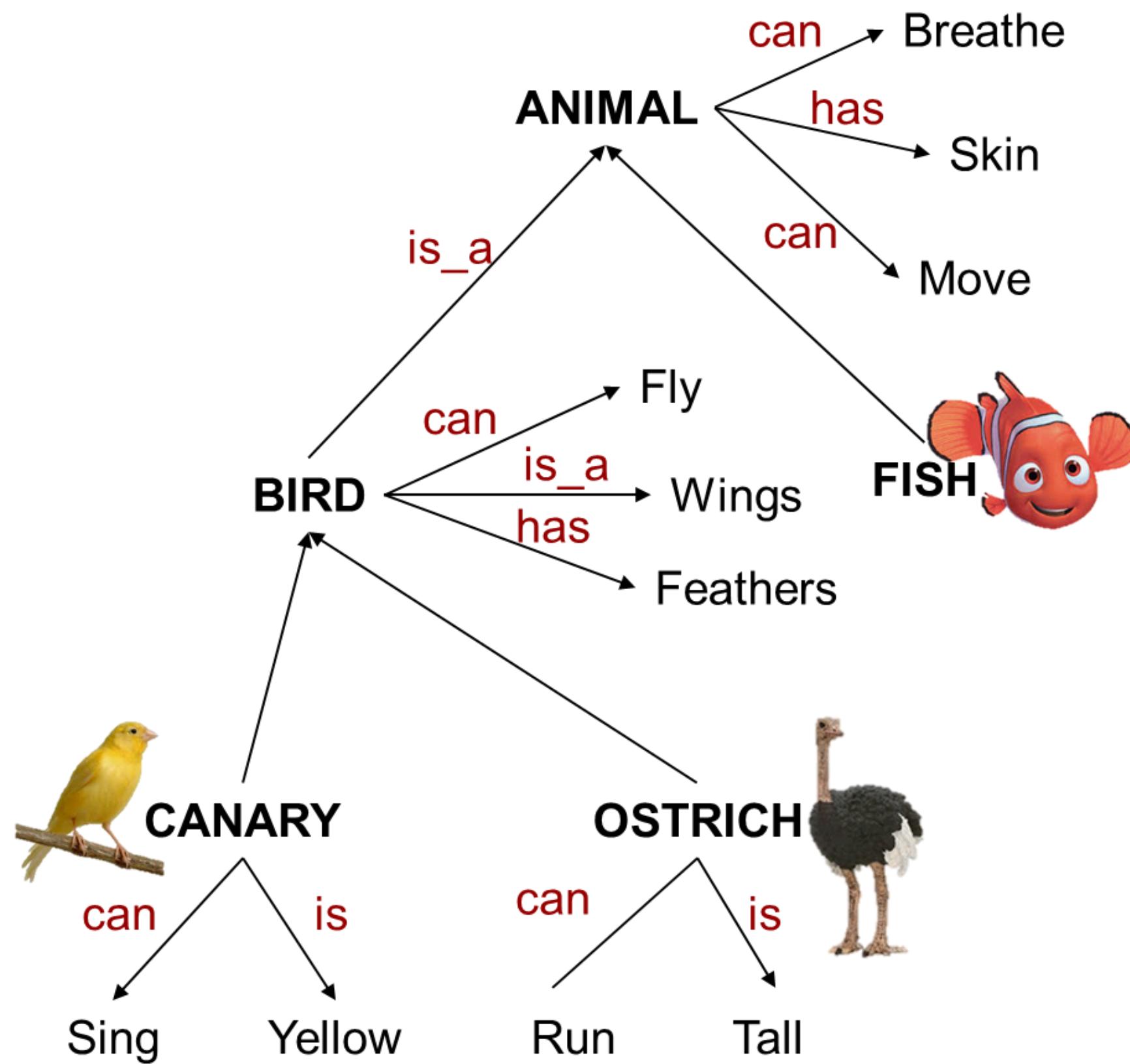


2. “Tweety the bird, can sing”



SPOT THE MISTAKE

SEMANTIC NETS



TRY THIS

SEMANTIC NETS

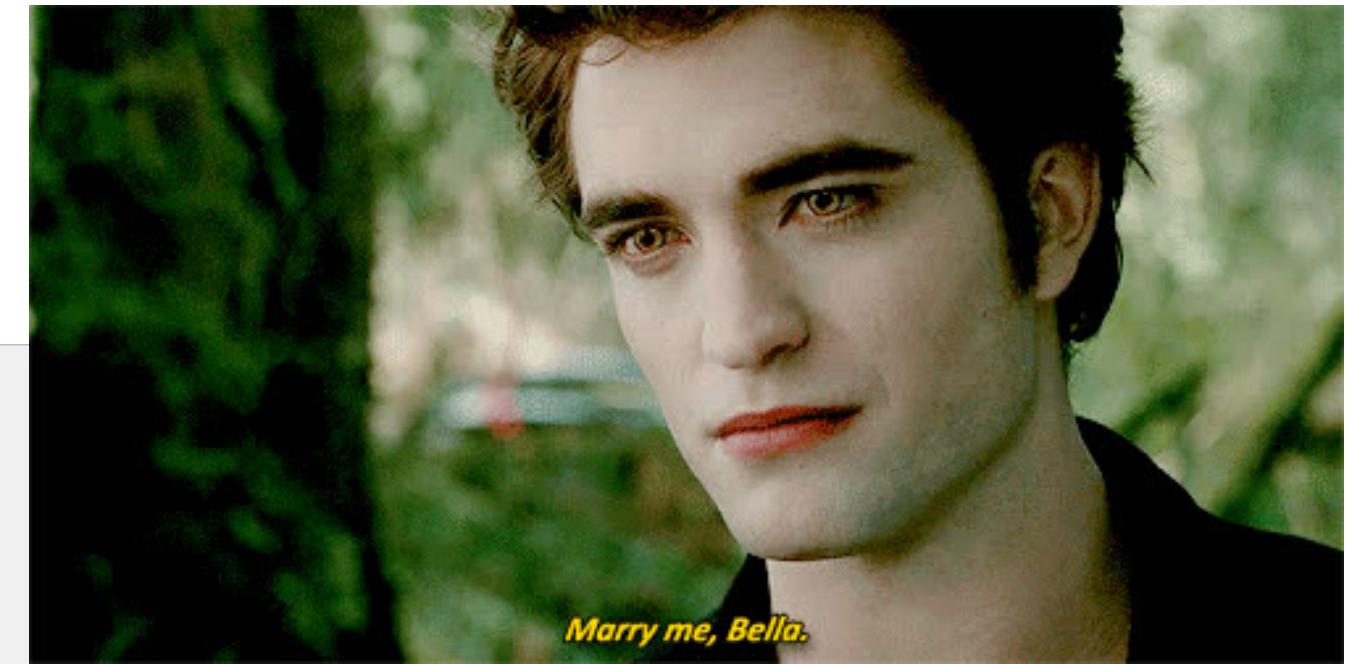
Represent the terms below into ONE semantic network.

Edward is a vampire.

Edward's girlfriend, Bella is a human.

Jacob is a werewolf and he is Bella's childhood friend.

Werewolf is the enemy for vampire.



TRY THIS

SEMANTIC NETS

Represent the terms below into ONE semantic network.

When travelling to a new place, there are options of staying in a hotel, farm, or homestay. The three lodgings offer a variety of facilities such as water heater and sauna. There are animals in farm. Rabits and sheep are both common. Homestay, on the other hand, has a shared lounge and free Wi-fi

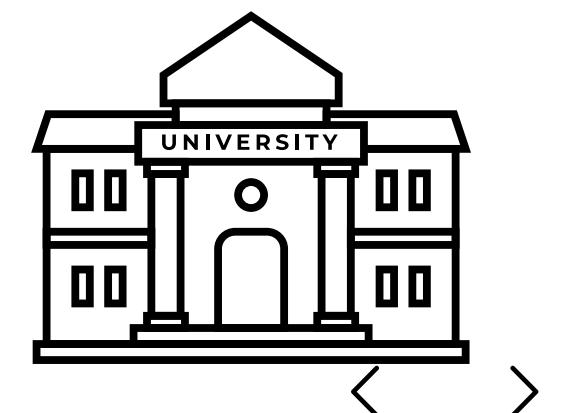


TRY THIS

SEMANTIC NETS

Represent the terms below into ONE semantic network.

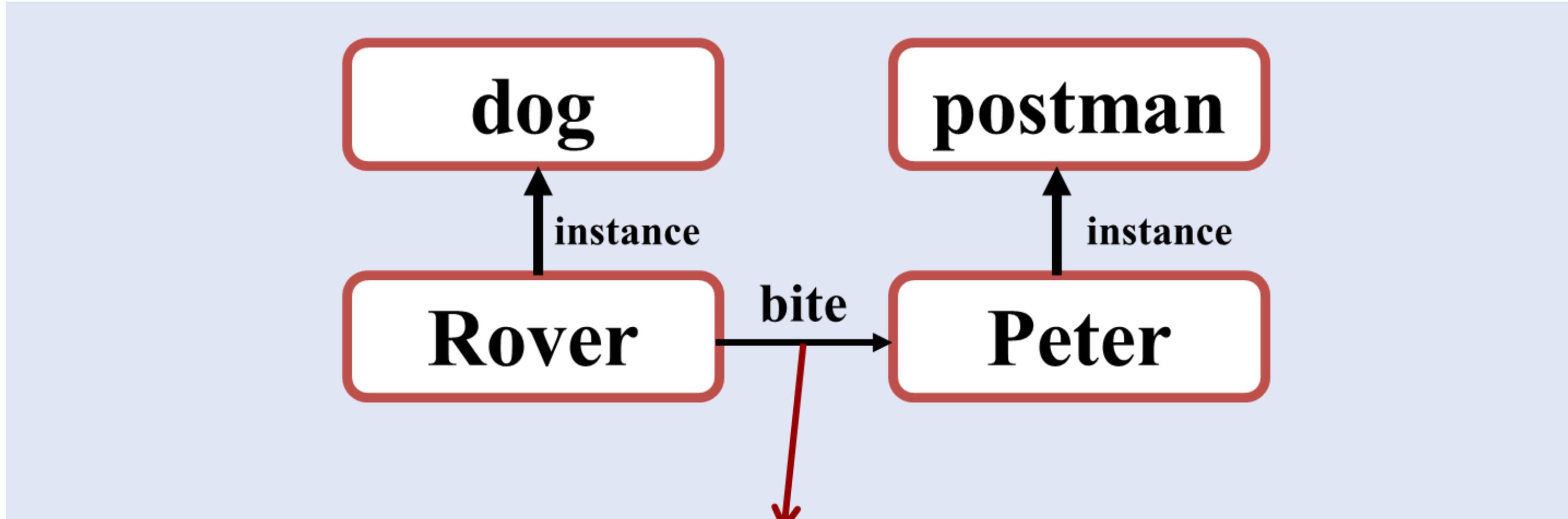
Colleette University is one of the top 20 Universities worldwide. It was established in 1950 with the focus of providing the best quality education with world class facilities and resources regardless of any field of studies. Colleette University offers 6 programmes at degree level which are engineering, ICT, accountancy, business, applied science and multimedia design. Today, Colleette University has more than 45,000 students including international students from more than 10 countries.



EXTENDING SEM. NETS (NOT QUANTIFIED)

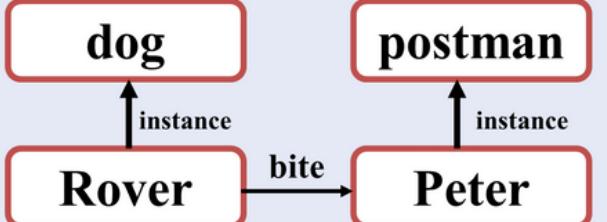
Rover, the dog bit Peter, the postman

$dog(Rover) \wedge bite(Rover, Peter) \wedge postman(Peter)$



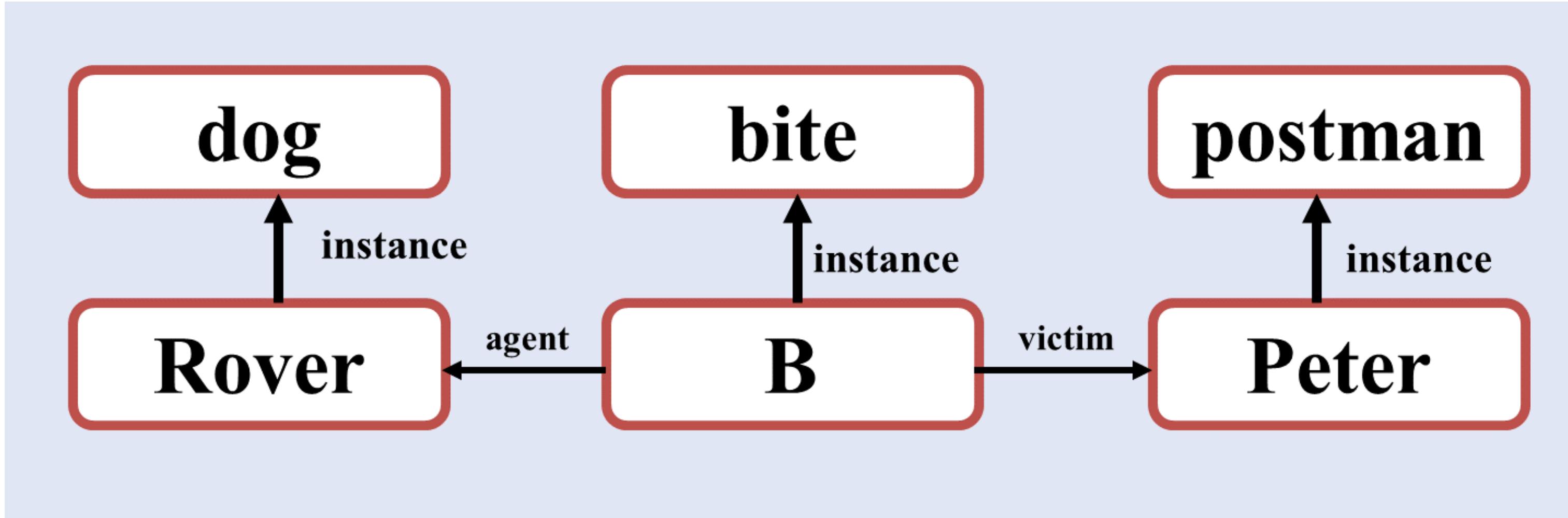
if we also would like to extend the event *bite*...

EXTENDING SEM. NETS (NOT QUANTIFIED)



Rover, the dog bit Peter, the postman

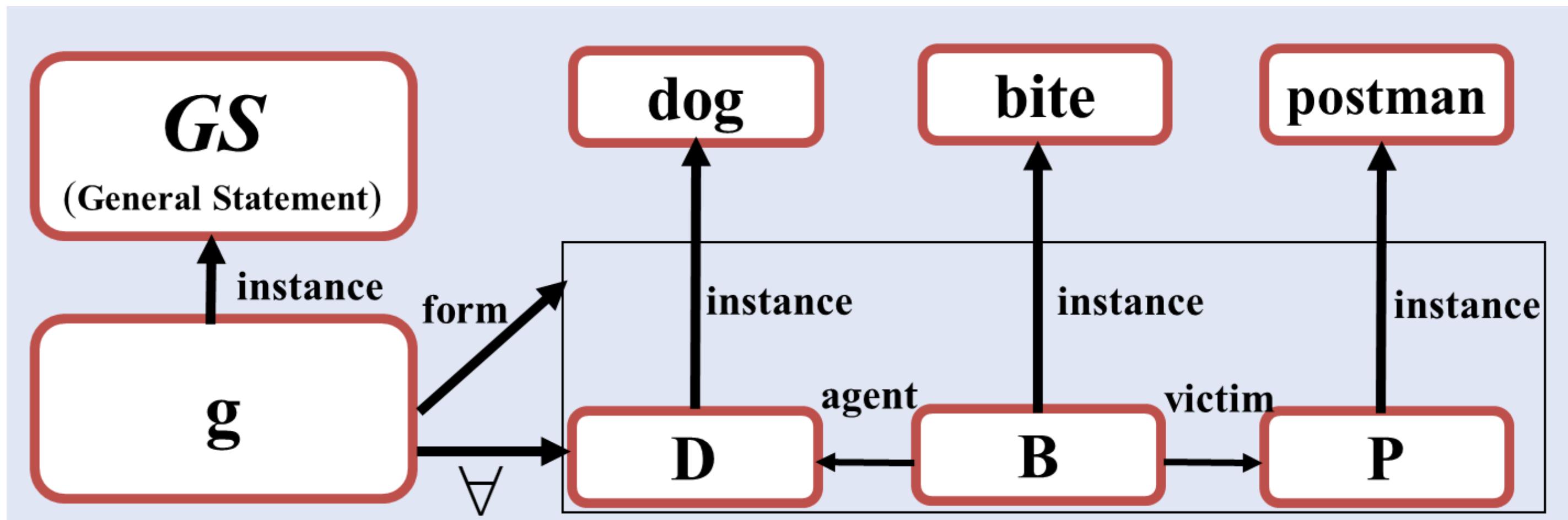
$dog(Rover) \wedge bite(Rover, Peter) \wedge postman(Peter)$



EXTENDING SEM. NETS (QUANTIFIED)

Partitioned Semantic Networks allow expressions to be quantified.

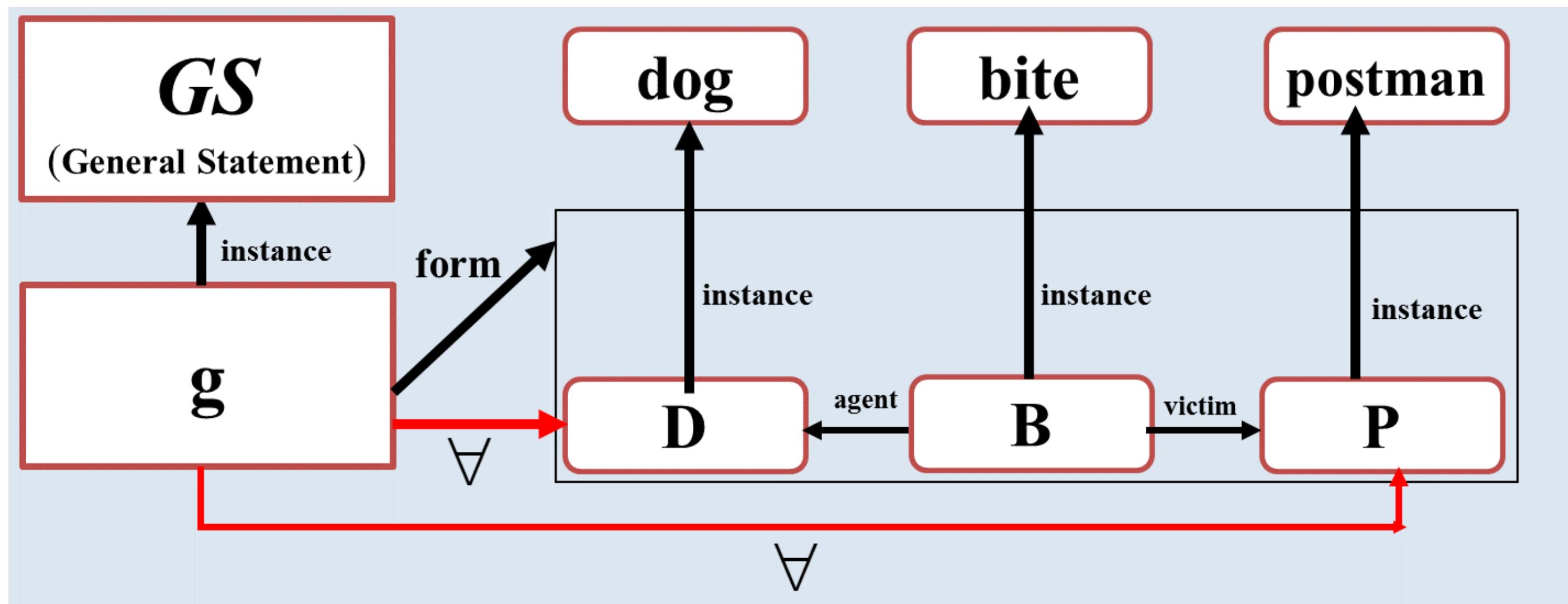
Every dog has bitten a postman

$$\forall D: \text{dog}(D) \rightarrow \text{bite}(D, P) \wedge \text{postman}(P)$$


EXTENDING SEM. NETS (QUANTIFIED)

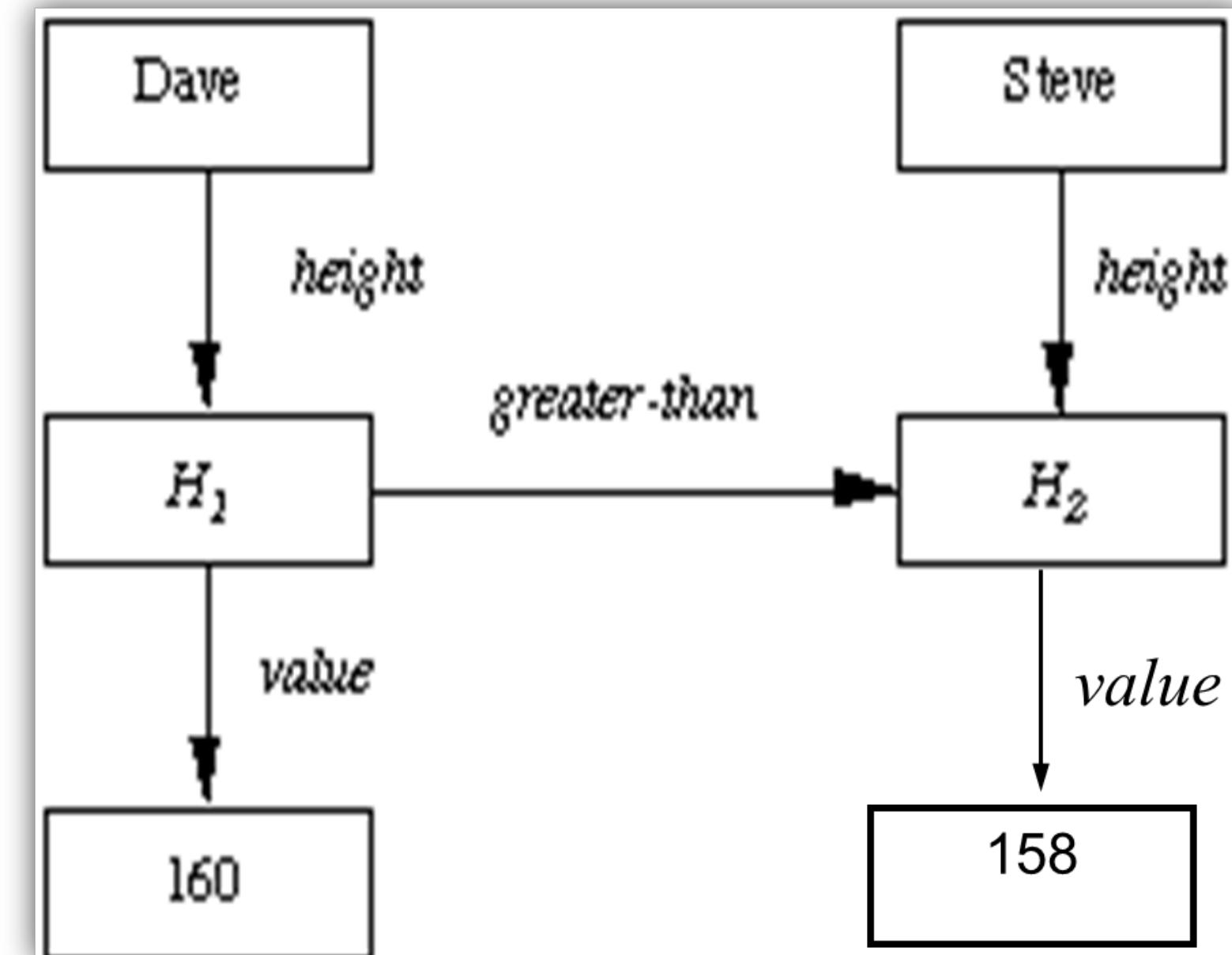
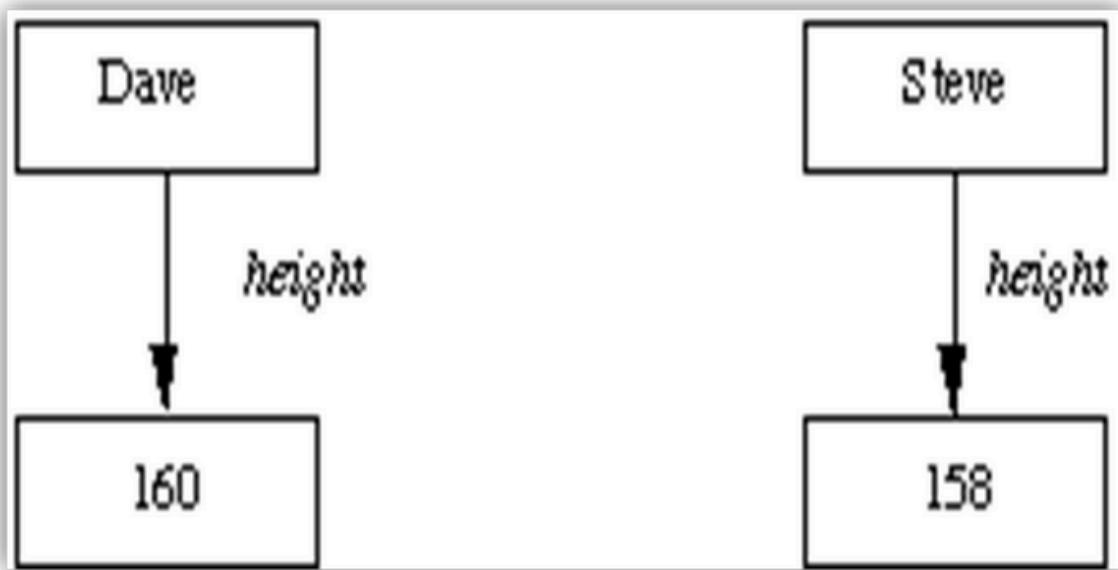
Partitioned Semantic Networks allow expressions to be quantified.

Every dog has bitten every postman

$$\forall D \ \forall P: \text{dog}(D) \rightarrow \text{bite}(D, P) \wedge \text{postman}(P)$$


COMPARING 2 OBJECTS

The height of two people is depicted as below:



REPRESENTING NON-BINARY PREDICATES

Binary predicate involves only 2 arguments/objects, e.g.

- *team(Ronaldo, Portuguese)*.

The part of a sentence or clause containing a verb and stating something about the subject (e.g. "The dog chased the cat," the predicate is "chased the cat." It expresses the action performed by the subject "The dog."

Non-binary predicate involves more than 2 arguments, e.g.

- *score(Portuguese, Morocco, 0-1)*.

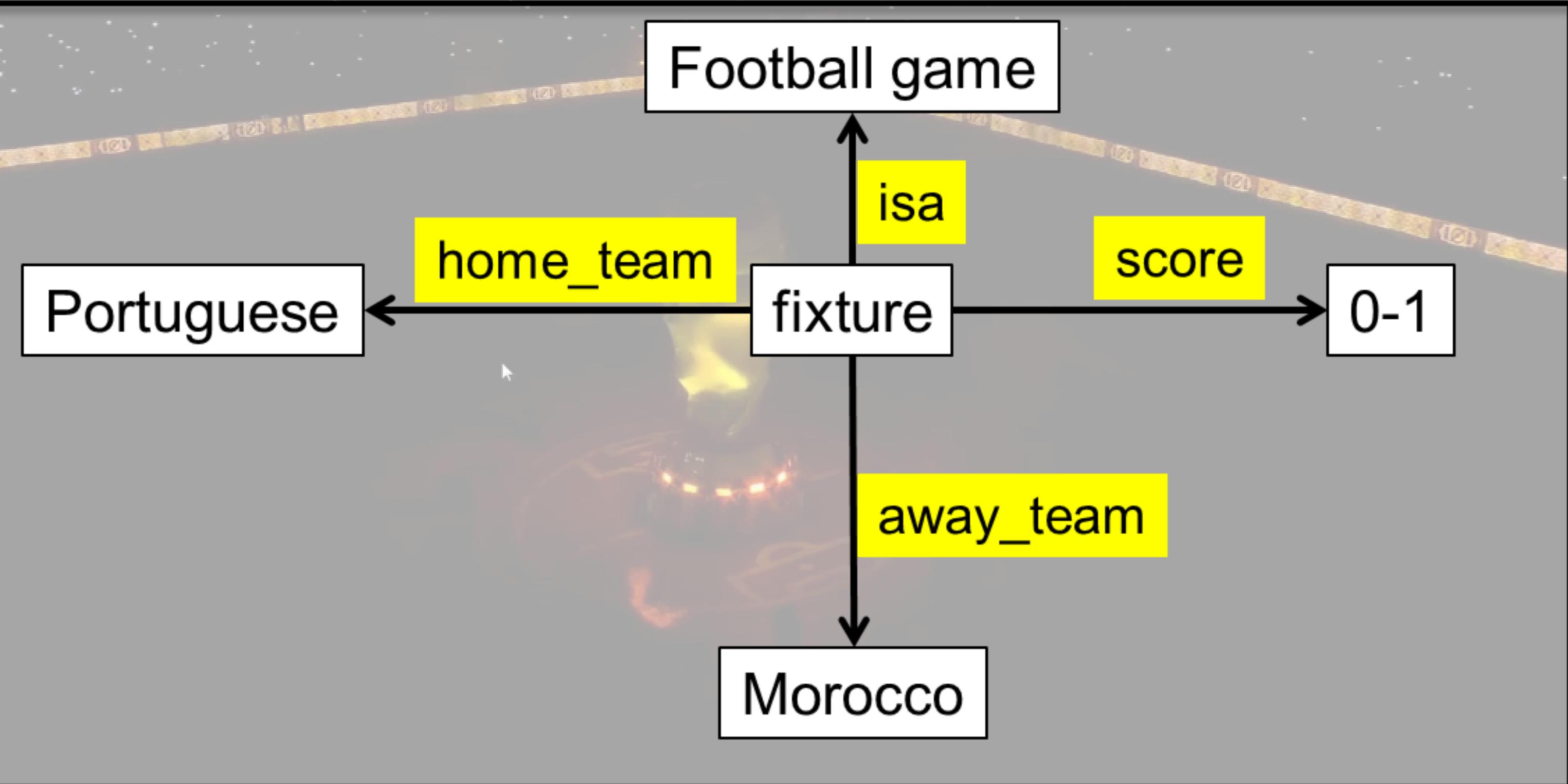
To create a semantic network that represents non-binary predicate:

1. Create new nodes (add more information)
2. Relate (new) information to nodes



EXAMPLE

NON-BINARY PREDICATES

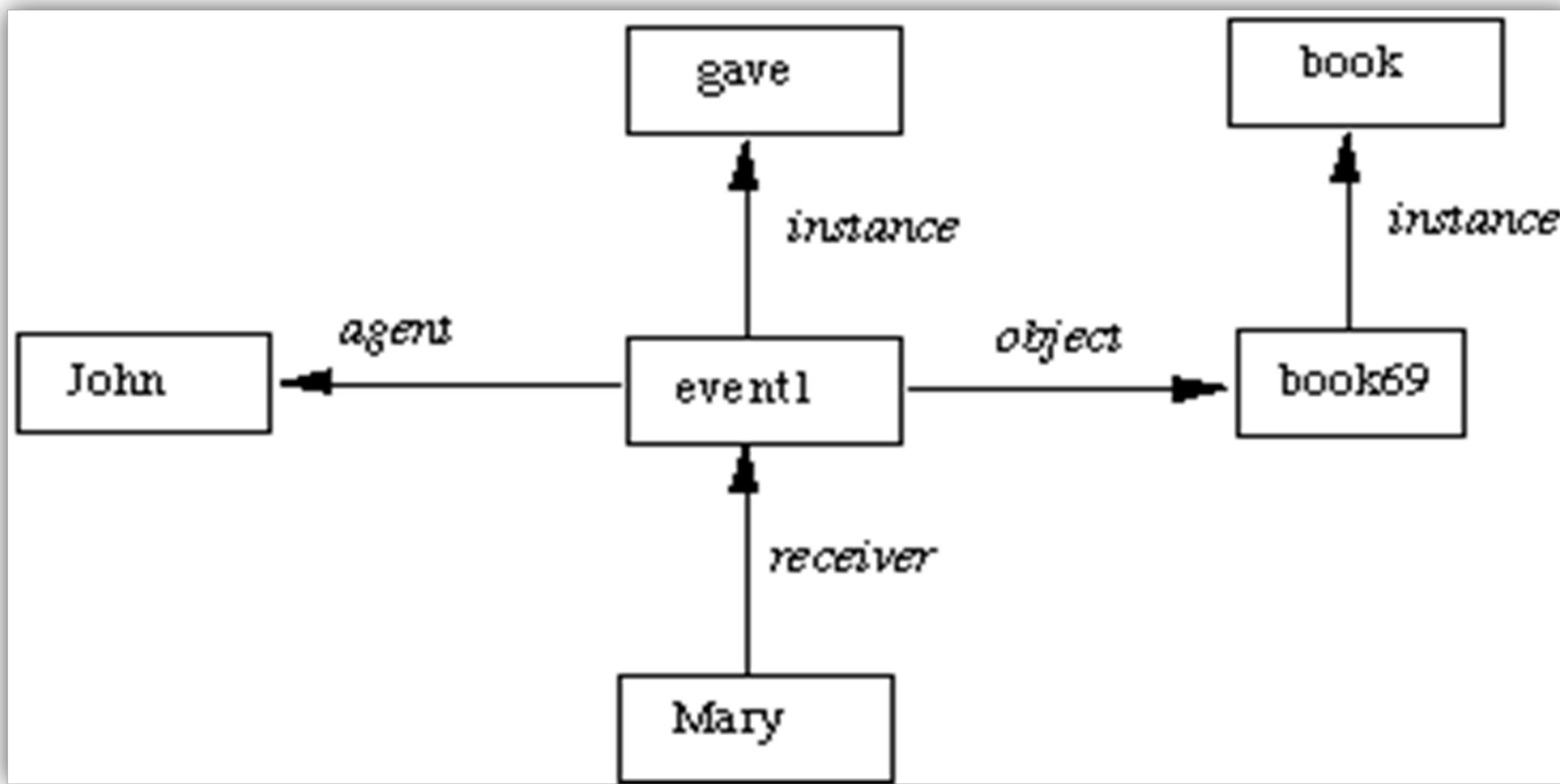
score(Portuguese, Morocco, 0-1)

EXAMPLE

NON-BINARY PREDICATES

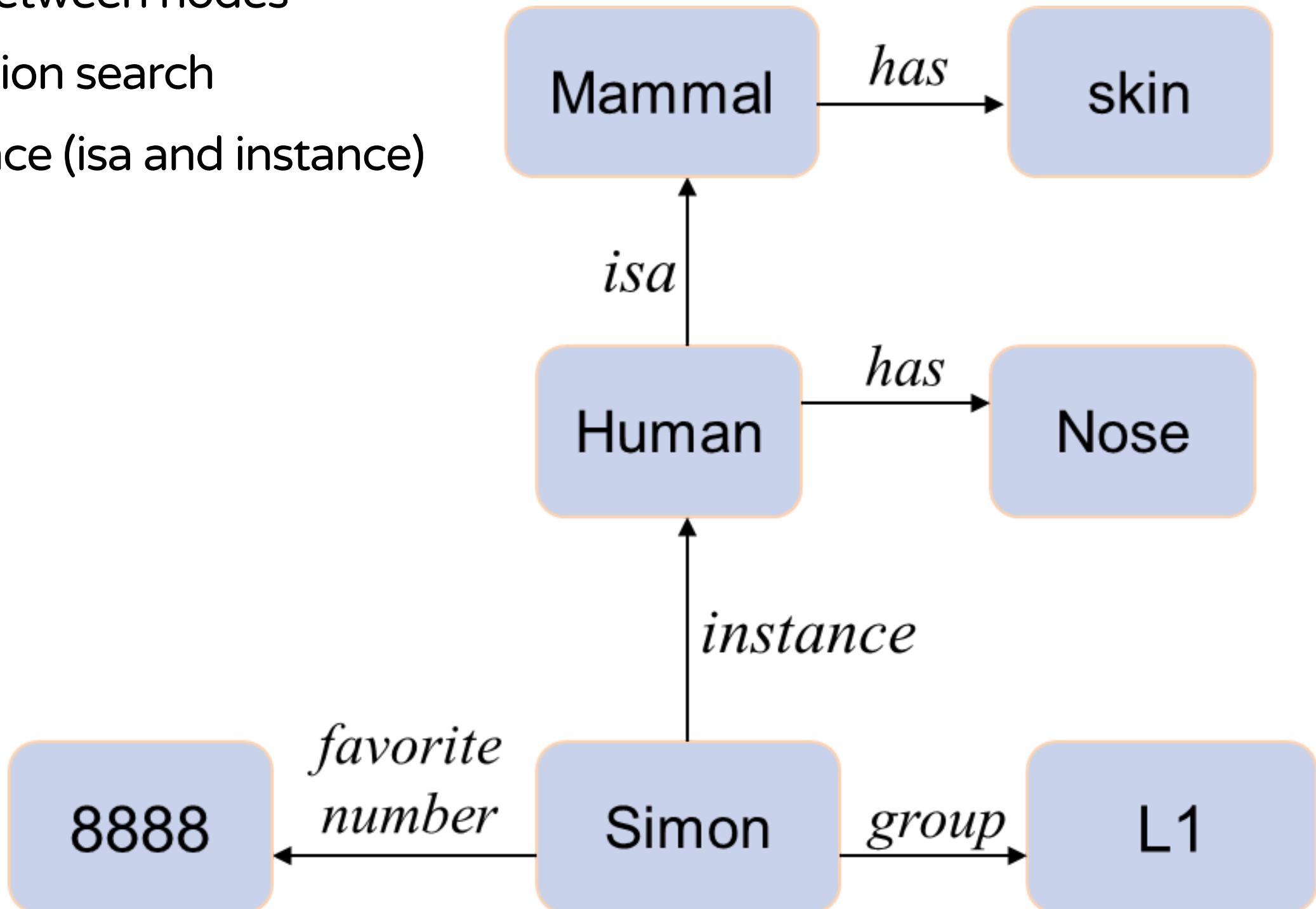
“John gave the book to Mary.”

`gave(John, Mary, book)`



INFERENCE IN SEMANTIC NETS

- Follow between nodes
- Intersection search
- Inheritance (isa and instance)



Consider these queries:

1. What is a mammal?
2. Who is Simon?
3. Simon has What?

What are the outputs?

SUMMARY

SEMANTIC NETWORKS

ADVANTAGES

1. Easy to visualize and understand
2. Related knowledge is easily categorized
3. The knowledge engineer can arbitrarily defined the relationships

DISADVANTAGES

1. No standards about node and arc values
2. This not describes the attributes

CONCEPTUAL GRAPH

- The nodes of the graph are either concepts or conceptual relations.
- Do not use labeled arcs
- Conceptual relations nodes represent relations between concepts.

CG are based upon the following general form:



EXAMPLE

CONCEPTUAL GRAPH

the following information is given:

- Sidnee is a small dog.
- Sidnee bites a postman very hard.

instance(sidnee, dog), size(sidnee, small)

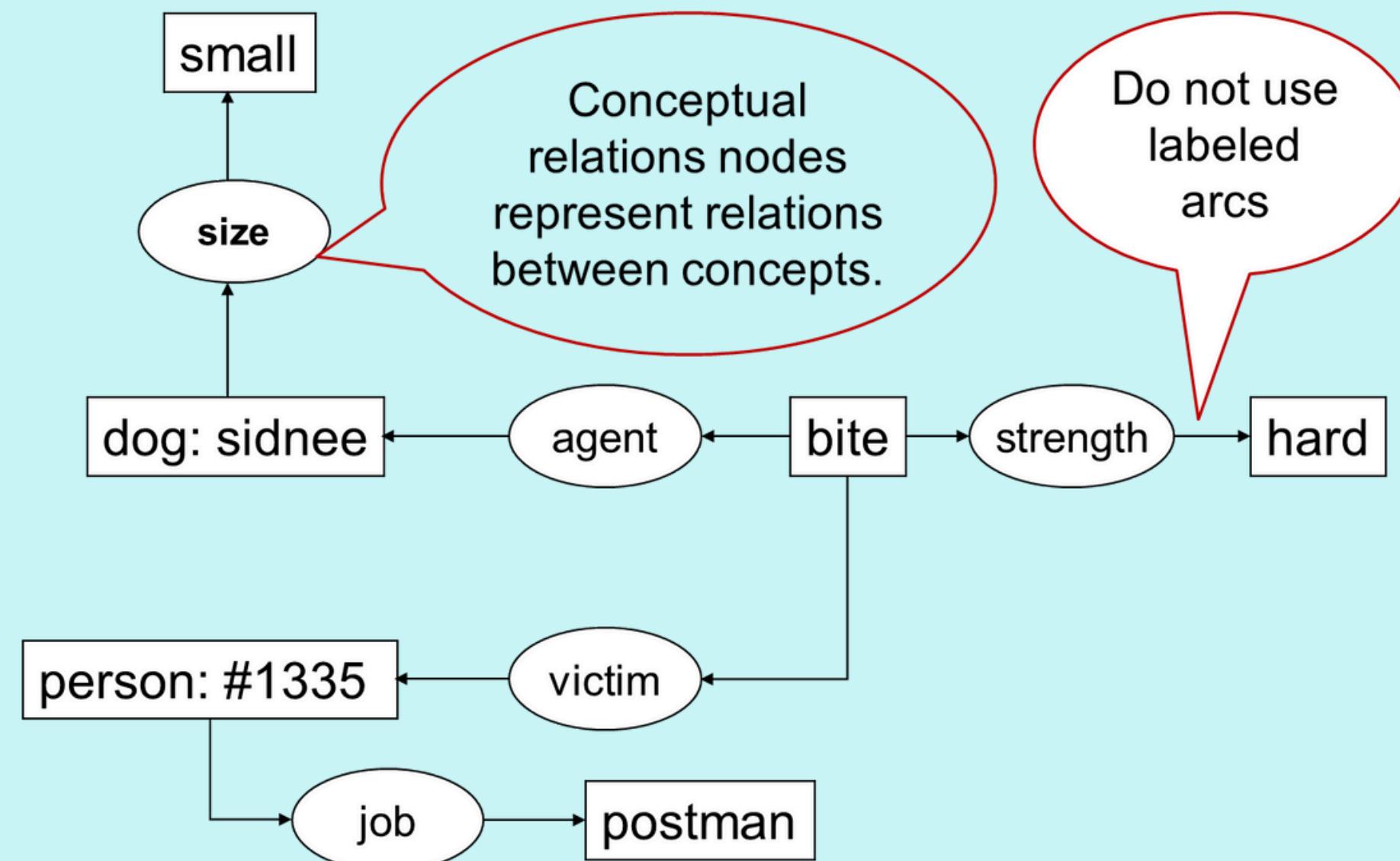
bites(sidnee, postman), strength(bite, hard)

EXAMPLE

CONCEPTUAL GRAPH

instance(sidnee, dog), size(sidnee, small)

bites(sidnee, postman), strength(bite, hard)



AND/OR GRAPH

- It's known as hypergraph
- Some call it as inference network
- Suitable for rule-based system: It is a graphical representation of the reduction of problems (or goals) to conjunctions and disjunctions of subproblems (or subgoals) in Hierarchical Structure. This structure facilitates the representation of decision processes, where decisions at a higher level are broken down into sub-decisions or conditions at lower levels.
- The nodes represent states or goals, and their successors are labeled as either "AND" or "OR". The "AND" successors are subgoals that must all be achieved to satisfy the parent goal, while "OR" branches indicate alternative subgoals, any one of which could satisfy the parent goal

AND/OR GRAPH

- Involves logical operators and and or
- Expression $q \wedge r \rightarrow p$
 - (both q and r must be true for p to be true)
- Expression $q \vee r \rightarrow p$
 - (q or r is sufficient to prove p is true)
 - Also can be written as $q \rightarrow p, r \rightarrow p$

EXAMPLE

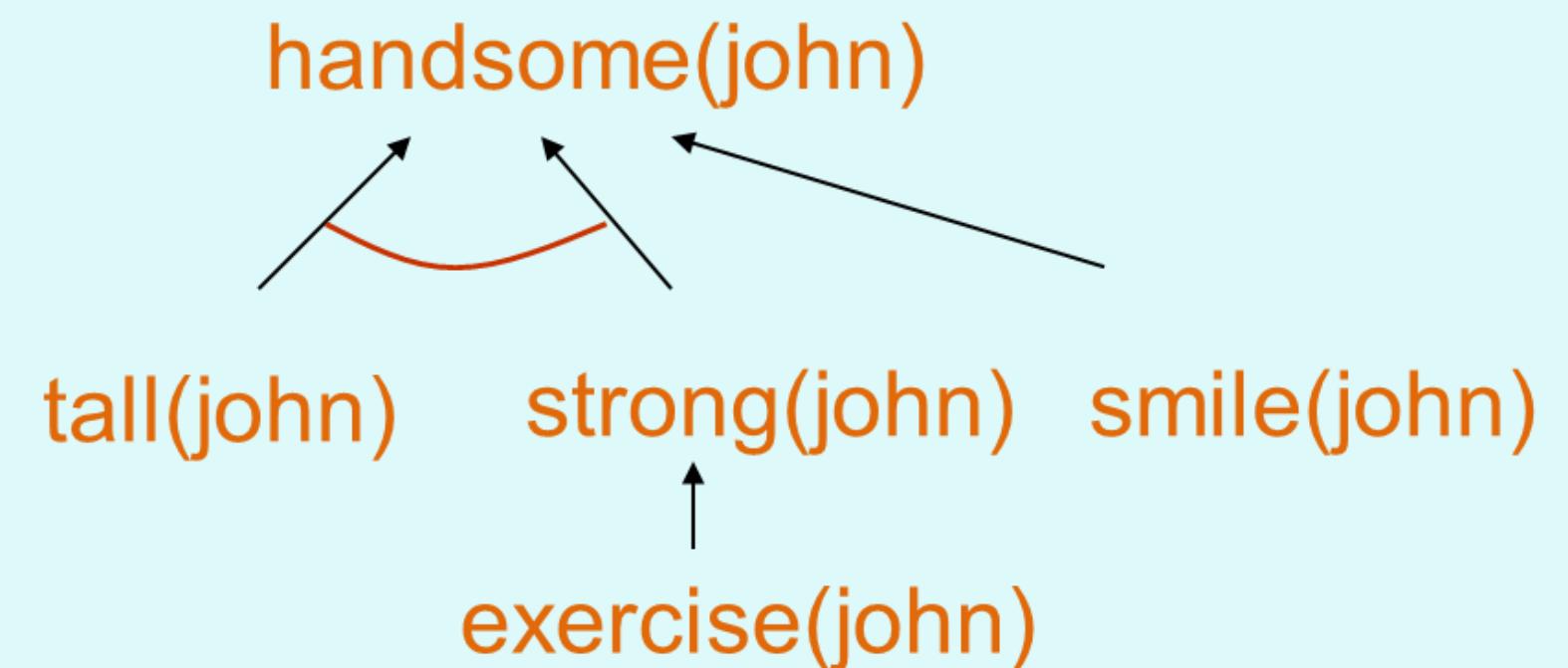
AND/OR GRAPH

IF john smiles,
THEN he looks handsome

IF john is tall and strong,
THEN he looks handsome

IF john does exercise,
THEN he is strong

The graph will look like this:



TRY THIS

AND/OR GRAPH

Below are the rules for a car purchase rule-based system.

R1: IF The car exterior conditions are poor
 OR The car interior conditions are poor
 THEN The overall condition of the car is poor (CF=0.8)

R2 IF The car mileage exceed 150,000 km
 AND The car engine is noisy
 THEN The overall condition of the car is poor (CF=0.9)

R3 IF The car service doesn't follow the maintenance schedule
 AND The overall condition of the car is poor
 THEN Do not buy the car (CF=0.9)

(i) Develop the AND/ OR graph based on the rules given above.

FRAMES

- Data structures used to divide knowledge into substructures by representing "stereotyped situations"
- Structured record that describes an entity in the world, such as an object or event, by using a collection of attributes and their values
- These attributes are often referred to as "slots", and the values they hold are called "facets"

FRAMES

Computer

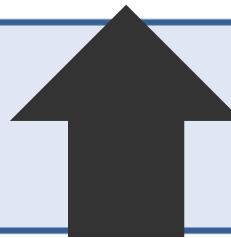
ISA: CLASS

MODEL:

PROCESSOR:

MEMORY:

PRICE:



ASUS

Instance: Computer

Processor: Quad-Core i7 3.6GHz

Memory: 4 GB

Price: RM3699

✓ Structured/organized and concise

✓ Represent a stereotyped object or concept.

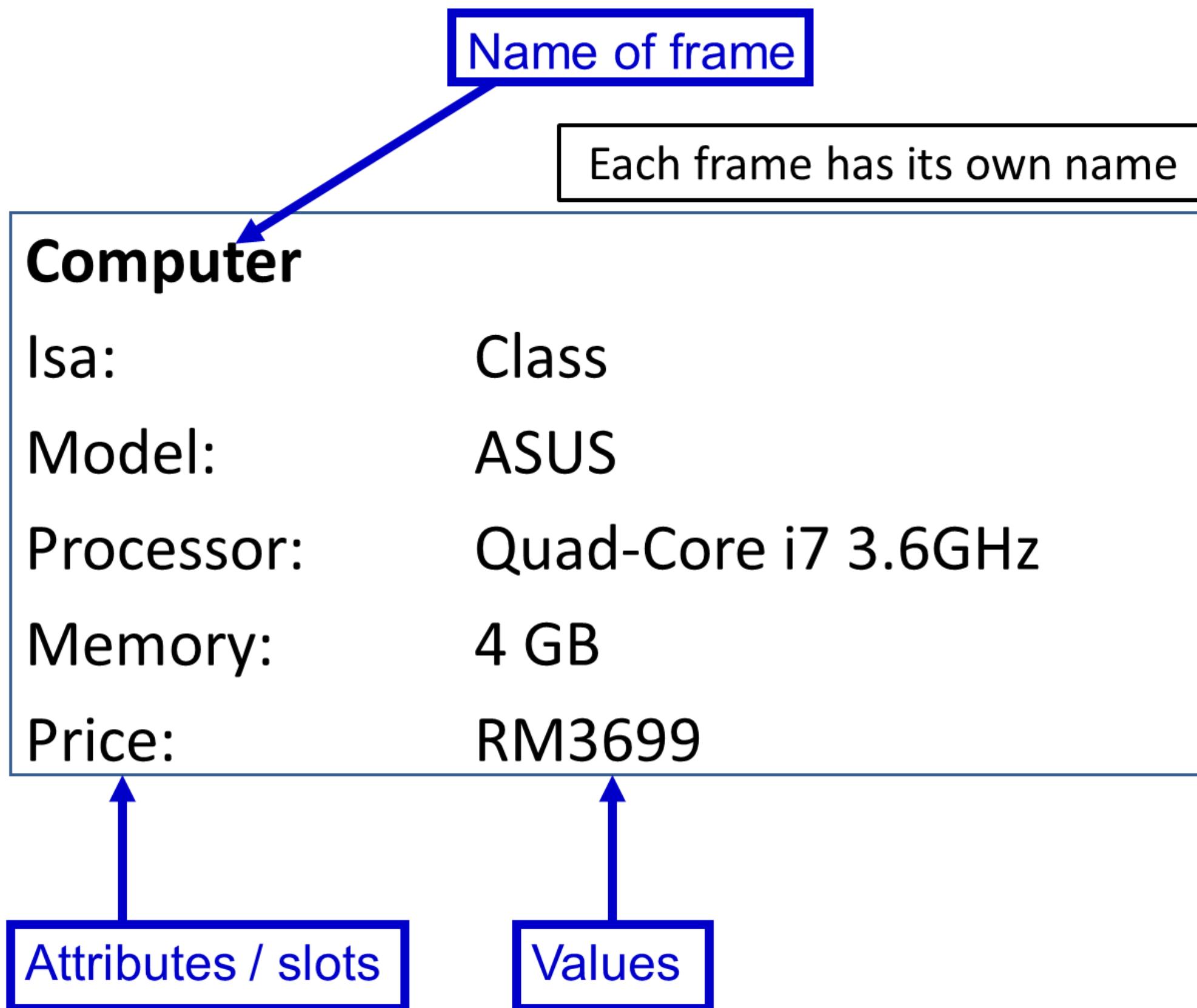
✓ describe various attributes and characteristic of an object or real world entity in detail.

shows implicit connections of information in a problem domain (inheritance)

Basically an application of object-oriented programming

EXAMPLE

FRAMES



EXAMPLE

FRAMES

Bird

Isa: Class

Covering: Feathers

Locomotion: Flies

Ostrich

Isa: Bird

Locomotion: Walks

Tweety

Instance: Bird

Fred

Instance: Ostrich

Mammal

Isa: Class

Covering: Hair

Locomotion: Walks

Lion

Isa: Mammal Java: public class Lion extends Mammal{ }

Sinba

Instance: Lion Java: Lion Sinba = new Lion();

Isa: Relationship
between 2 classes

Instance: Instantiation of
an object from a class

EXAMPLE

FRAMES

<i>Bird</i>	Frame Name
<i>Is-a-class</i>	
[String]	Covering:
[N]	Number of Wings:
[String]	Locomotion:
Canary	Cardinality: 1 billion [Initial]
Class: <i>Bird</i>	
[String]	Locomotion: Flies [Default]
[N]	Cardinality: 1 million [Initial]
Tweety	Pointer (to show inheritance)
Instance: <i>Canary</i>	
[String]	Locomotion: Walk
[N]	Cardinality: 1

- New instance information:
Class-frame may establish unspecified value for certain slots
- Instance-frame will establish values for all slots

SUMMARY

FRAMES

ADVANTAGES

Expressive power

- Easy to understand
- Represent stereotyped object
- More detail than semantic network

Flexible

- Easy to set up slots / new properties
- Easily create specialized procedures
- Allow default data
- Easily detect missing value

Show inheritance

- Show hierarchical structure

Show constraints

- Allow constraints to be set for value / facets

DISADVANTAGES

Difficult

- Difficult to program, especially making inference

Limited

- Not suitable to describe sequence of events, action, etc
- Not description on syntax/semantic of a sentence, etc “bank”

Incomplete

- Individual frame cannot give full picture
- Details may be omitted during representation
- Cannot be quantified, e.g. “all”, “some”

SOME JARGONS IN FRAMES

Jargons

- Facet
- Slots
- Demon

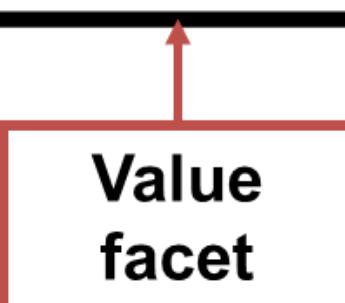
Synonyms

- Details, features
- Attributes
- Procedures

FACETS

- To establish the attribute value
- To control end-user queries
- Tell the inference engine how to process the attribute
- Value facets: specify [default] and [initial] values of an attribute.
- Prompt facets: prompt for user's input
- Inference facets: to stop inference process

CLASS: <i>Bird</i>			
[String]	<i>Covering:</i>	Feathers	[Default]
[N]	<i>Number of Wings:</i>	2	[Default]
[String]	<i>Locomotion:</i>		
[N]	<i>Cardinality:</i>	1 billion	[Initial]

Value facet  **facets** 

SLOTS

- Slots may include
 - a) Range of slot value (e.g. the range of age)
 - b) Descriptors of requirements
 - c) Attributes as objects
 - d) Procedural information (procedures/operations)
- Provide extension to the slot-value structure through facets*

(A) USE SLOTS TO SHOW RANGE/CONSTRAINT

Represent the following statement using frames

- Hulk's height is 2.7 meters.
- Hulk is taller than Thor.

Superhero

ISA: Class

Hulk

Instance: Superhero

[Float] Height: 2.7 [Units: meters, Constraint: > Thor's height]



(B) USE DESCRIPTORS IN SLOTS

Represent the following statement using a frame with appropriate descriptors

Team is a class. The cardinality refers to the number of existing teams. The team size is determined by the number of players.

Team

isa: Class

cardinality:{number of existing teams}

team size: {the number players}

(C) SLOTS (ATTRIBUTES) AS OBJECTS

- A slot is a relation that maps from its domain of classes to its range of values.
- A relation is a set/class of ordered pairs so one relation is a subset of another.
- Since slot is a set (class), the set of all slots can be represented by a metaclass called Slot.

<i>Slot</i>		
isa:	Class	
instance:	Class	
*domain:	attribute to be inherited	
<i>Baseball-Team</i>		
isa:	Team	
cardinality:	26	
team size:	24	
*manager:	slot as an object (another frame)	
<i>Manager</i>		
instance:	Slot	
domain:	Baseball-Team	

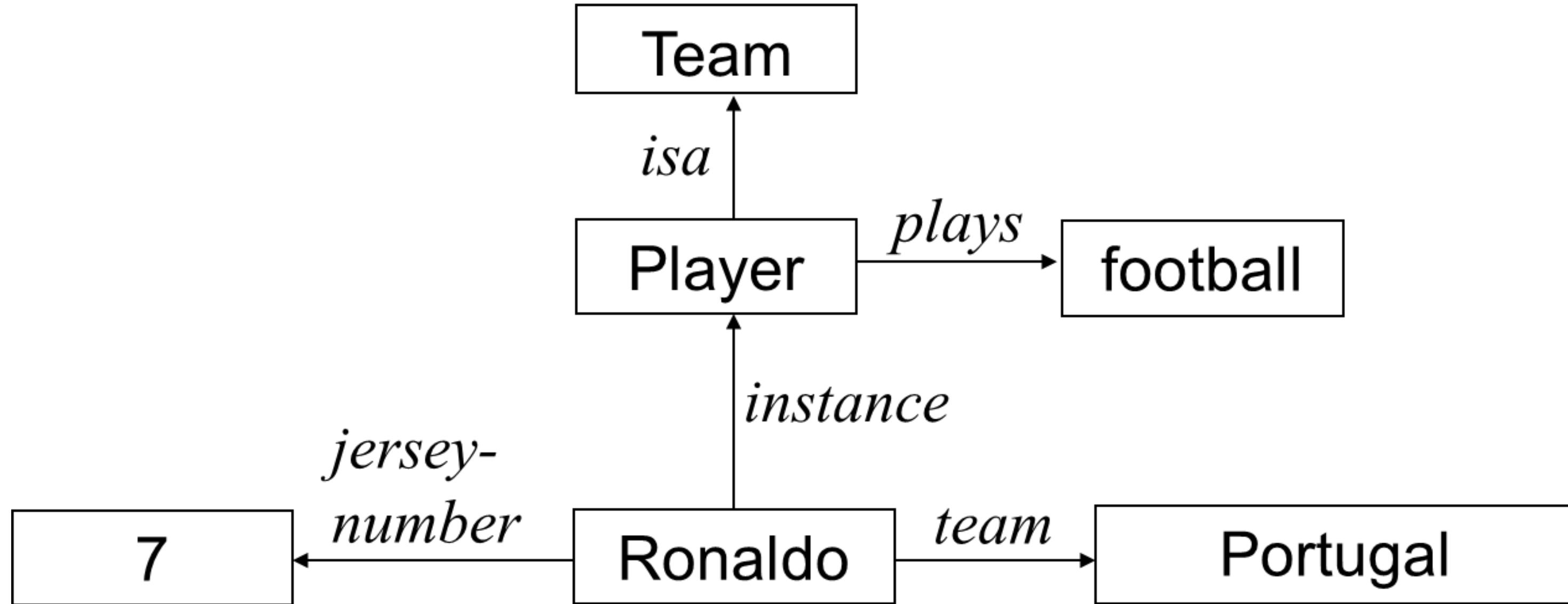
(D) SLOTS WITH PROCEDURES (DEMONS)

SLOTS WITH PROCEDURES, often referred to as "demons," are a feature in frame-based knowledge representation systems. They are procedural attachments that are associated with slots in a frame and are triggered by certain events related to the slot's value. There are typically four kinds of demons:

1. If-needed: Triggered when the value of the slot is accessed and the value needs to be computed or retrieved.
2. If-added: Triggered when a new value is added to the slot.
3. If-removed: Triggered when the value of a slot is deleted.
4. If-modified: Triggered when the value of a slot is modified.

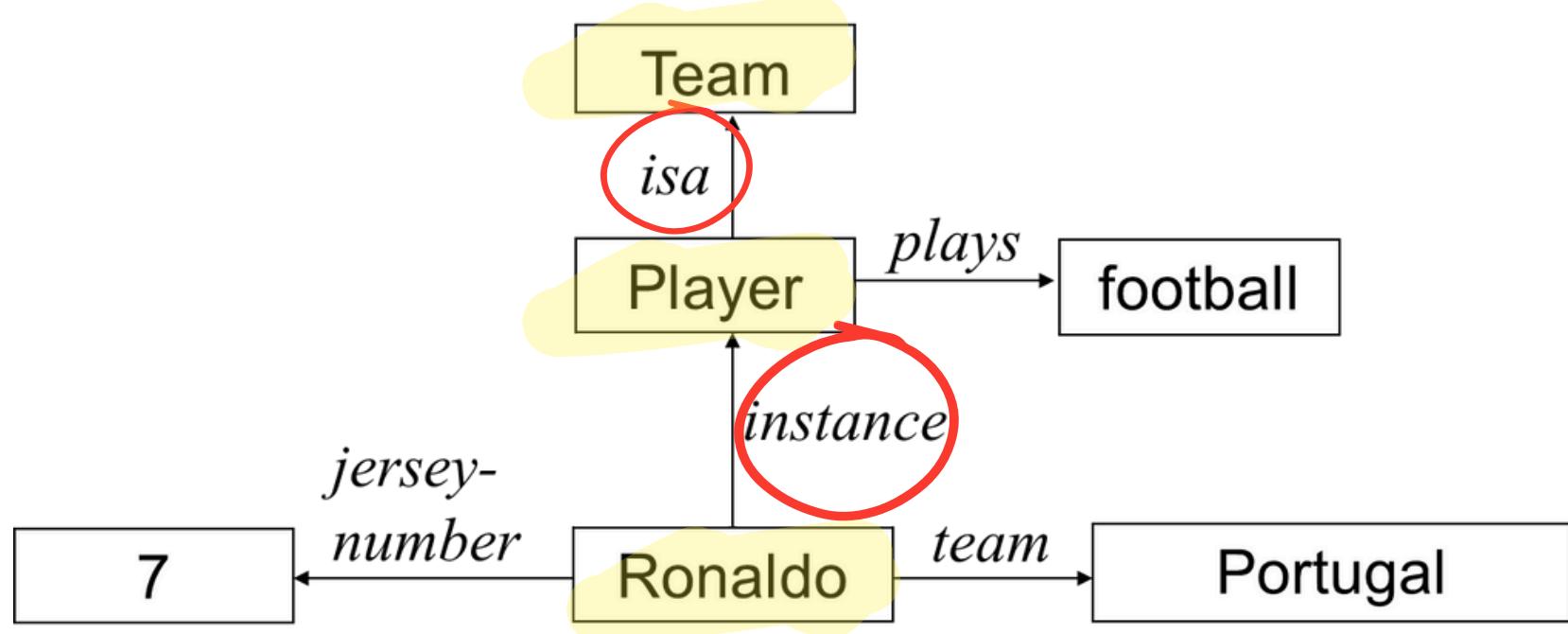
These demons allow frames to have dynamic behavior, enabling them to perform computations or take actions automatically in response to changes or queries to the data they contain. This makes the knowledge representation more powerful and flexible, as it can actively respond to the context of the system's operation.

SEMANTIC NETWORK TO FRAMES



Change the above semantic network to frame

SUGGESTED ANSWER



Team

isa: class

Player

isa: Team

play: football

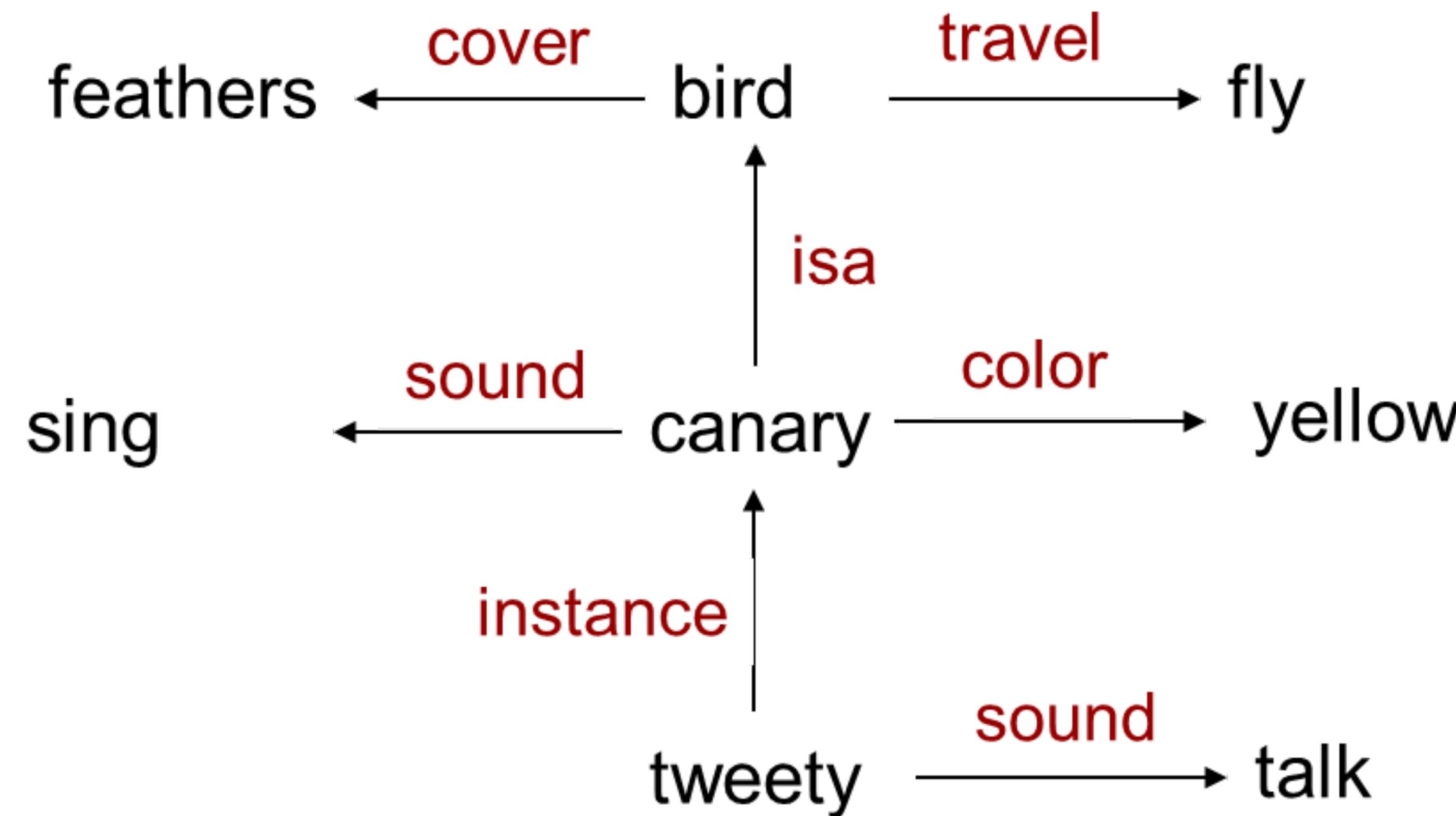
Ronaldo

instance: player

team: Portugal

jersey-number: 7

TRY THIS



THE END



NEXT LECTURE

Natural Language Processing