# Lecture 3

Continue to - Knowledge Representation

2.5.   Semantic Networks

semantic networks represents knowledge as a graph, with the nodes corresponding to concepts/facts in the problem domain, and the arcs to relations or associations between concepts.

The principle of semantic networks are as follows:-

- node is represented as a rectangle or circle to describe the objects, the concepts and the events.
- The arcs are used to connect the nodes.

تمثيل الأفعال والأحداث و الكائنات

لتمثيل العلاقة بين الكائنات
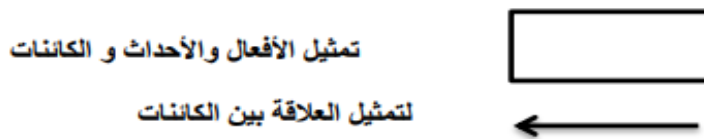
Arcs are divided into:-

1. Is a: ⟶ subclass of entity.
2. Inst ⟶ particular instance of a class

Country

inst

Iraq
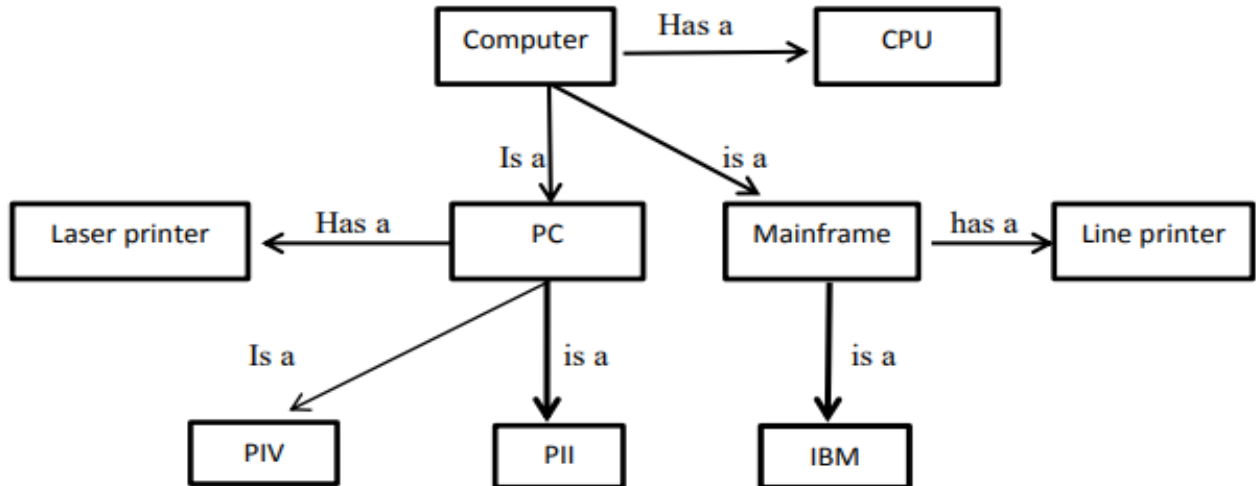
3. Prop ⟶ property link

Dog

prop

Bark
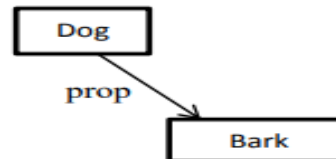
4. agent, receiver, object, time

في وصف اللغات الطبيعية فأن arcs تخرج من الفعل توضح او تشير الى الفاعل (agent)

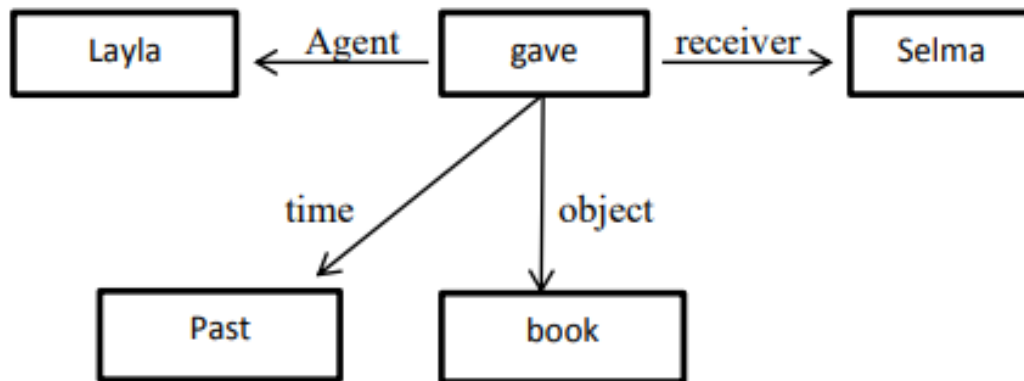والمستقبل (Receiver) والكائن (object) كما تشير الى وقت حدوث الفعل أي في الماضي , الحاضر او المستقبل.

- A semantic network can be used to generate rules for a knowledge base.

Example1:

Computer has many part like a CPU and the computer divided into two type, the first one is the mainframe and the second is the personal computer ,Mainframe has line printer with large sheet but the personal computer has laser printer , IBM as example to the mainframe and PIII and PIV as example to the personal computer.

```
                    ┌──────────┐   Has a   ┌──────────┐
                    │ Computer │ ────────→ │   CPU    │
                    └──────────┘           └──────────┘
                       Is a    is a
┌───────────────┐  Has a  ┌──────┐      ┌───────────┐  has a  ┌──────────────┐
│ Laser printer │ ←────── │  PC  │      │ Mainframe │ ──────→ │ Line printer │
└───────────────┘         └──────┘      └───────────┘         └──────────────┘
     Is a          is a                      is a
   ┌──────┐      ┌──────┐                  ┌──────┐
   │ PIV  │      │ PII  │                  │ IBM  │
   └──────┘      └──────┘                  └──────┘
```

Example 2: Layla gave Selma a book

```
┌──────────┐   Agent   ┌──────────┐  receiver  ┌──────────┐
│  Layla   │ ←──────── │   gave   │ ─────────→ │  Selma   │
└──────────┘           └──────────┘            └──────────┘
              time            object
         ┌──────────┐      ┌──────────┐
         │   Past   │      │   book   │
         └──────────┘      └──────────┘
```
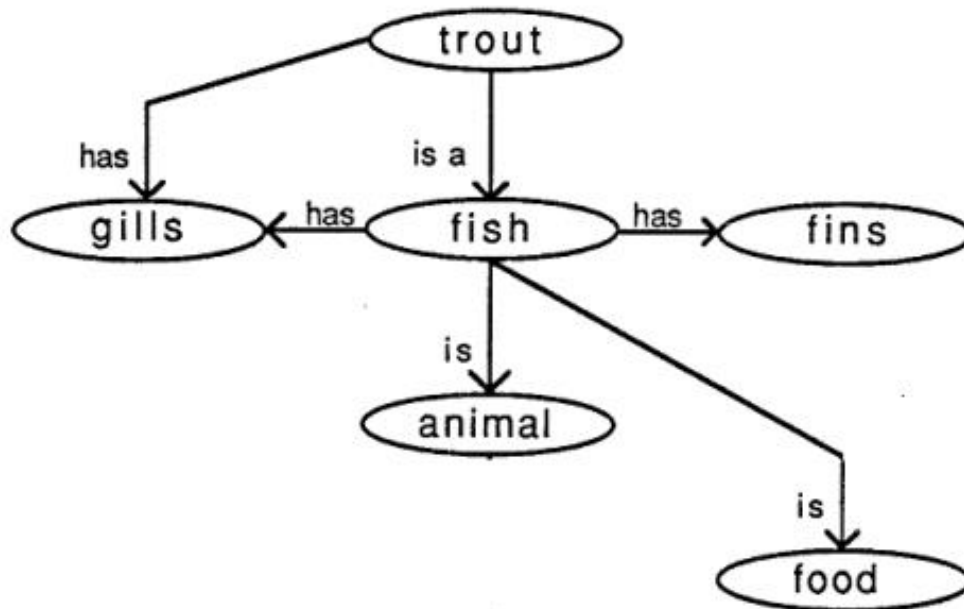
Example2: Create the semantic network for the following facts (Note: You must append new indirect facts if they exist):

   1- A trout is a fish.
   2- A fish has gills.
   3- A fish has fins.
   4- Fish is food.
   5- Fish is animal.

Solution:

There is a fact must be added that is "A trout has gills" because all the fishes have gills. The semantic network is shown below:

Example 3:- create semantic network from the following facts

   - Tom is a cat.
   - Tom caught a bird.
   - Tom is owned by John.

- Tom is ginger in color.

- Cats like cream.

- The cat sat on the mat.

- A cat is mammal.

- A bird is an animal.

- All mammals are animals.

- Mammals have fur.
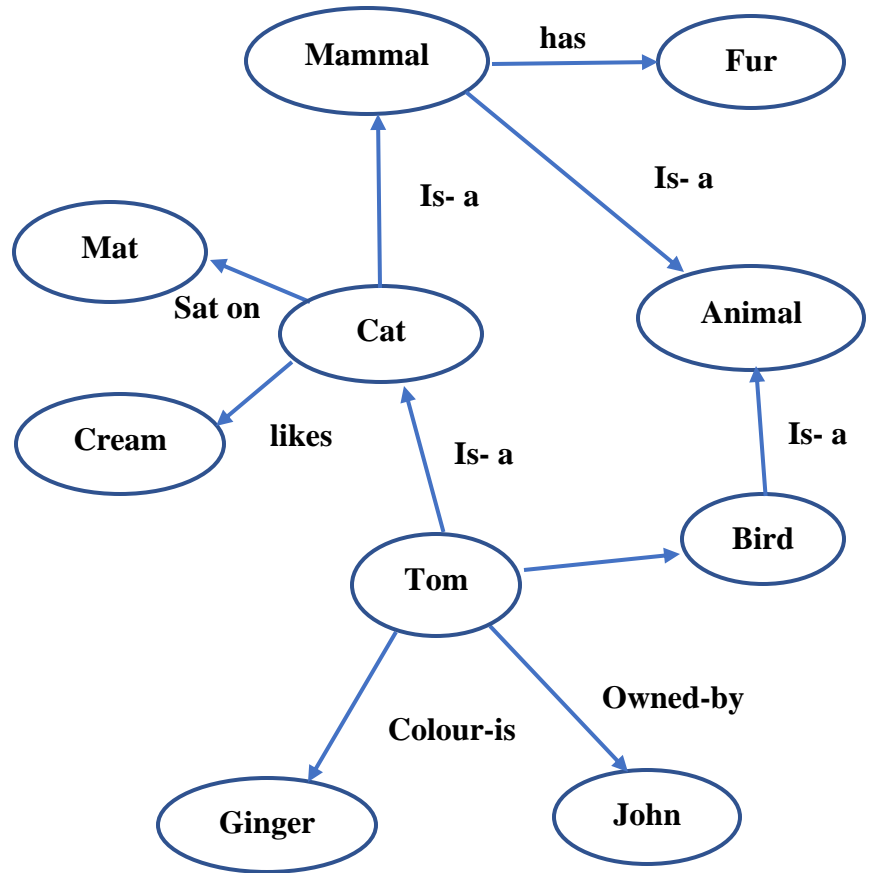
Example 4 :- Let us look at how the following English sentences can be represented using a semantic network. "Frosty is a snowman. A snowman is made of snow. Snow is frozen water. It is slippery and soft. Snow is cold. Ice is also cold. It is also frozen water, but unlike snow, which is soft, ice is hard. Ice is clear in color."
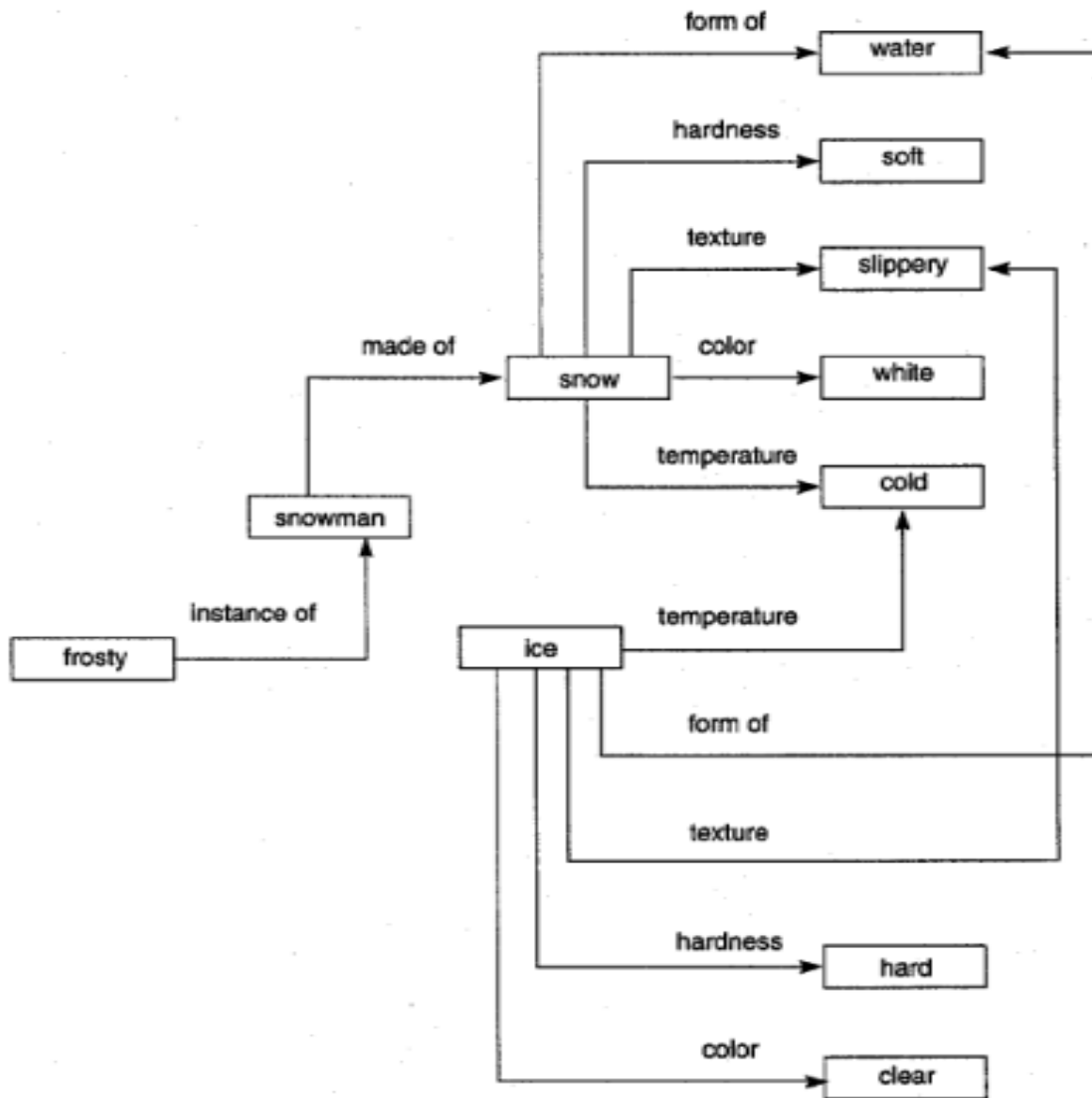

Figure 4:- Semantic network for Frosty, snowman, ice, and snow.

Example 5:- create semantic network and prolog program from the following facts:-

- **A bird is an animal.**
- **A bird is active at day light.**
- **The moving method of a bird is flying.**
- **Al batross is a bird so, is the kiwi.**
- **Albert &Ross are albatross.**
- **The color of albatross is black & white.**
- **Kim is kiwi.**
- **The moving method kiwi is walking.**
- **A kiwi is active at the night.**
- **The color of kiwi is brown.**
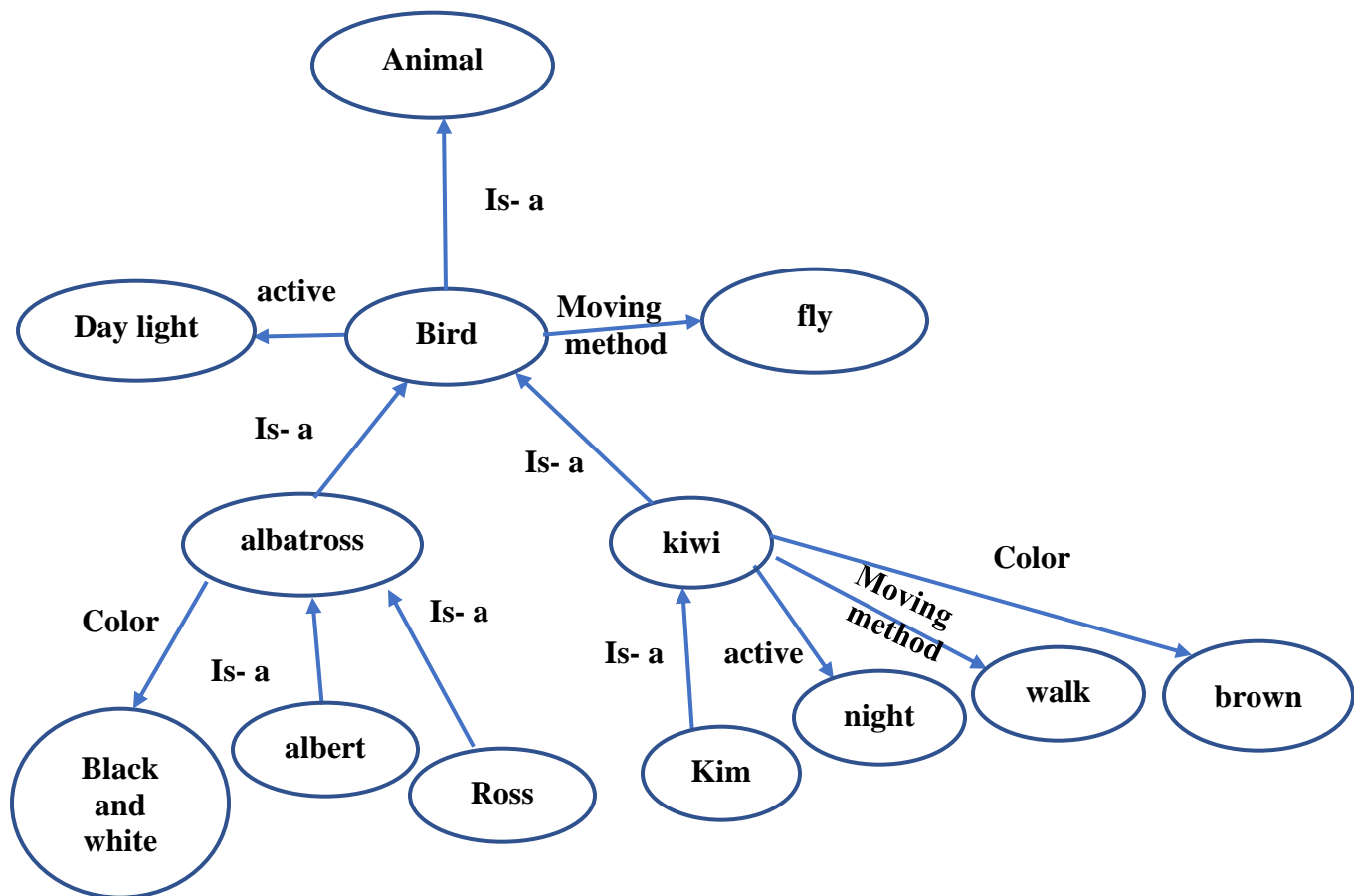
Domains

S=string

Predicates

Is-a (S,S).

Color(S,S).

Moving-method(S,S).

Active(S,S)

Clauses

Is-a (bird, animals).

Is-a (albatross, bird).

Is-a (kiwi, bird).

Is-a (kim, kiwi).

Is-a (ross, albatross).

Is-a(X,Y):- is-a(X,Z), is_a(Z,Y).

Moving-method(bird, flying).

Moving-method(kiwi, walking).

Moving-method(X,Y):- is-a(X,Z), Moving-method(Z, Y).

Color(albatross, black-and-white):-!.

Color(kiwi, brown):-!.

Color(X,Y):- is-a(X,Z),color(Z,Y).

Active(kiwi, night):-!.

Active(bird, daynight).

Active(X,Y):-is-a(X,Z), active(Z,Y).

Advantages of semantic networks

- Formal definitions of semantic networks have been developed.

- Related knowledge is easily clustered.

- Efficient in space requirements.

- Objects represented only once.

- Relationships handled by pointers.

Disadvantages of semantic networks

- Inheritance (particularly from multiple sources and when exceptions in inheritance are wanted) can cause problems.

- Facts placed inappropriately cause problems.

- No standards about node and arc values

2.6.   Conceptual Graph

A conceptual graph is a finite, connected, bipartite graph. The nodes of the graph are either concepts or conceptual relations. Concepts are represented as boxes and relations as ellipses.

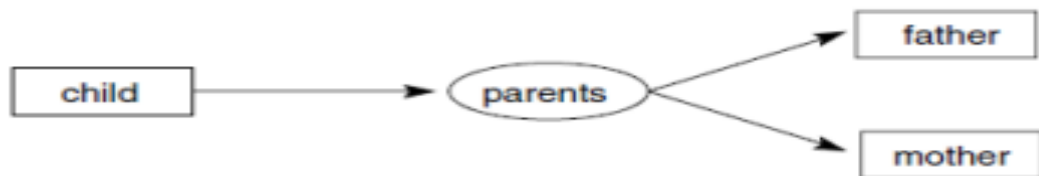**Examples1:-** represent the following concept using conceptual graph

-   a bird flies.
-   A dog has a color of brown.

```
┌──────┐          ⟶  ⟨ flies ⟩
│ bird │
└──────┘
```
Flies is a 1-ary relation.

```
┌──────┐     ⟶  ⟨ color ⟩  ⟶  ┌───────┐
│ dog  │                       │ brown │
└──────┘                       └───────┘
```
Color is a 2-ary relation.

```
                                      ┌────────┐
                                  ⟶   │ father │
┌───────┐                             └────────┘
│ child │  ⟶  ⟨ parents ⟩
└───────┘                             ┌────────┐
                                  ⟶   │ mother │
                                      └────────┘
```
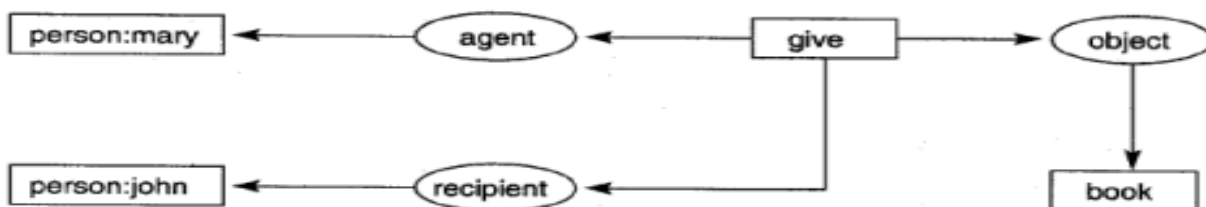Parents is a 3-ary relation.

Notice that the relation flies and color are stored in an ellipse node and the concepts bird, dog and brown are stored in boxes.

Example2:- is a graph of somewhat greater complexity that represents the sentence **"Mary gave John the book".** This graph uses conceptual relations to represent the cases of the verb "to give" and indicates the way in which conceptual graphs are used to model the semantics of natural language.

```
┌─────────────┐  ⟵  ⟨ agent ⟩  ⟵   ┌──────┐  ⟶  ⟨ object ⟩
│ person:mary │                     │ give │
└─────────────┘                     └──────┘        │
                                        │           ▼
┌─────────────┐  ⟵  ⟨ recipient ⟩  ⟵───┘        ┌──────┐
│ person:john │                                  │ book │
└─────────────┘                                  └──────┘
```

Examples 3:-

- A cat is on a mat

```
┌──────────┐           ╭──────╮          ┌──────────┐
│   Cat    │──────────▶│  on  │─────────▶│   Mat    │
└──────────┘           ╰──────╯          └──────────┘
```

- Every cat is on a mat

```
┌──────────┐           ╭──────╮          ┌──────────┐
│  Cat: ∀  │──────────▶│  on  │─────────▶│   Mat    │
└──────────┘           ╰──────╯          └──────────┘
```

- John is going to Boston by bus.

```
┌──────────────┐        ╭────────╮        ┌──────┐        ╭────────╮        ┌──────────────┐
│ Person: John │◀───────│ agent  │───────▶│  Go  │───────▶│  Dest  │───────▶│ City: Boston │
└──────────────┘        ╰────────╯        └──────┘        ╰────────╯        └──────────────┘
                                              │
                                              ▼
                                          ╭────────╮
                                          │  inst  │
                                          ╰────────╯
                                              │
                                              ▼
                                      ┌──────────────┐
                                      │ City: Boston │
                                      └──────────────┘
```
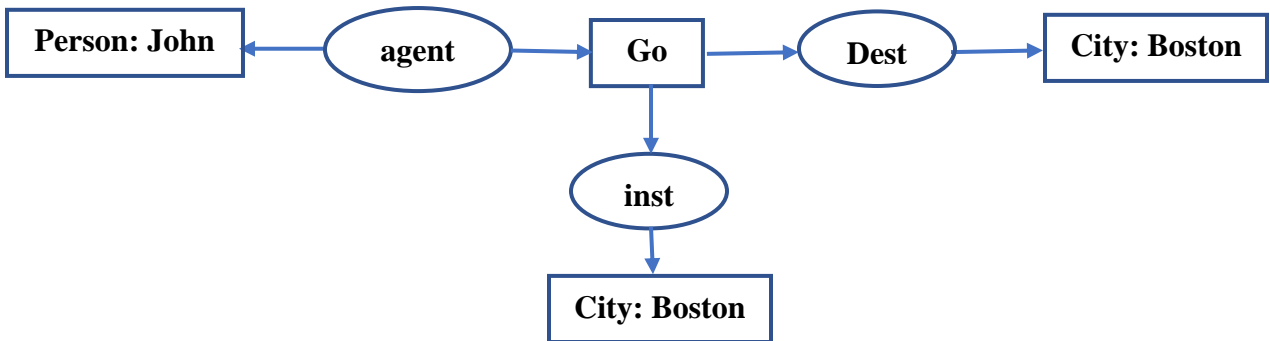
- A person is between a rock and a hard place.

```
                              ┌──────────┐
                              │   Rock   │
                              └──────────┘
                                    │
┌──────────┐       ╭────────╮       ▼
│  Person  │◀──────│  Betw  │◀──────┘
└──────────┘       ╰────────╯
                        ▲
                        │
                 ┌──────────┐       ╭────────╮       ┌──────────┐
                 │  Place   │──────▶│  Attr  │──────▶│   Hard   │
                 └──────────┘       ╰────────╯       └──────────┘
```
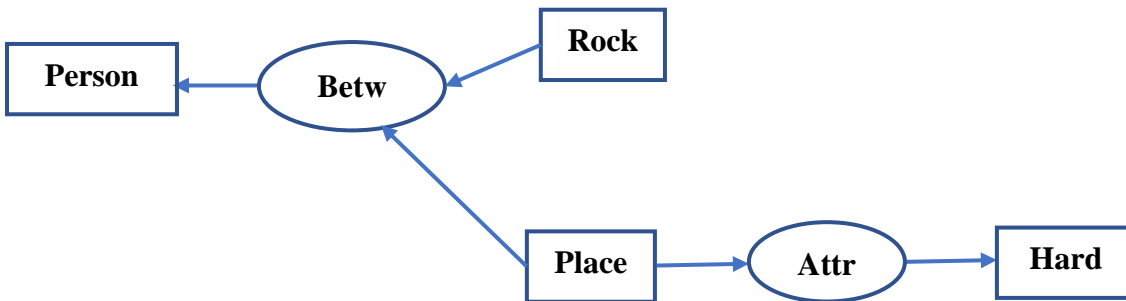
Example 1: Ahmed read a letter yesterday.

```
┌──────────┐        ╭────────╮        ┌──────┐        ╭────────╮        ┌──────────┐
│  Ahmed   │◀───────│ agent  │───────▶│ read │───────▶│ object │───────▶│  letter  │
└──────────┘        ╰────────╯        └──────┘        ╰────────╯        └──────────┘
                                          │
                                          ▼
                                      ╭────────╮
                                      │  time  │
                                      ╰────────╯
                                          │
                                          ▼
                                      ┌──────┐
                                      │ past │
                                      └──────┘
```
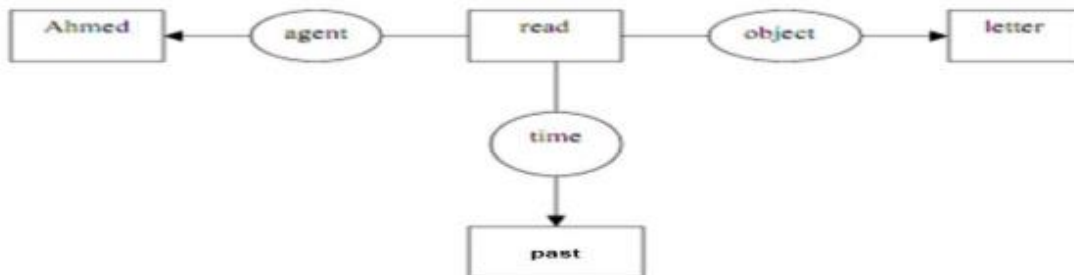
Figure (4-7): Conceptual graph indicating that the dog named emma is brown.

Figure (4-8): Conceptual graph indicating that a particular (but unnamed) dog is brown.
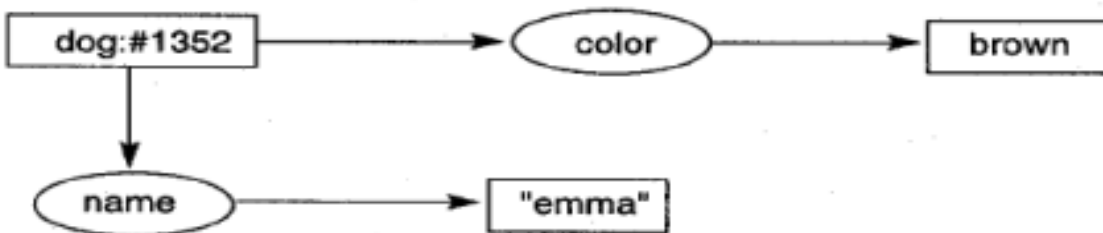

Figure (4-9): Conceptual graph indicating that a dog named emma is brown.

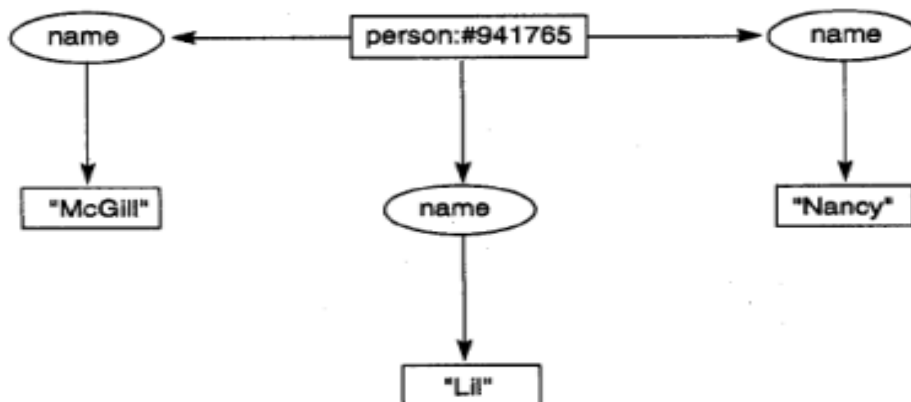"Her name was McGill, and she called herself Lil, but everyone knew her as Nancy".

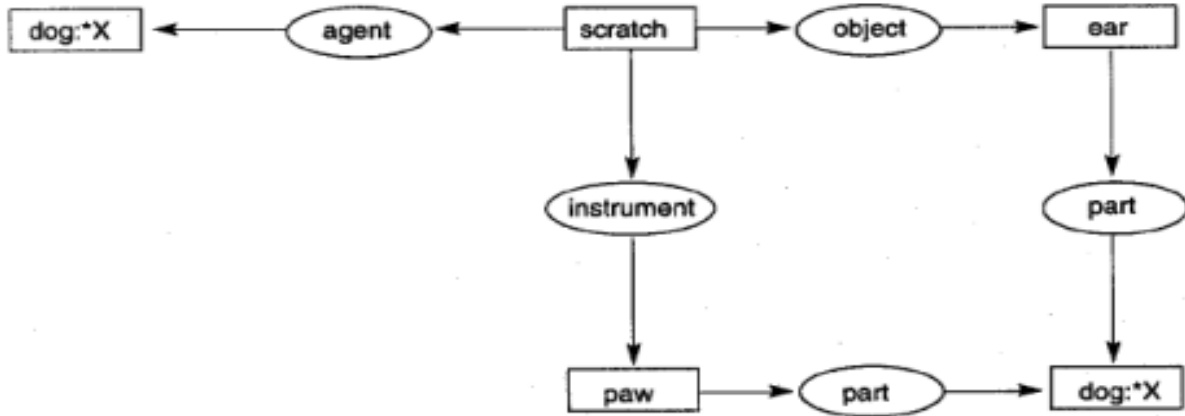Figure (4-10): Conceptual graph of a person with three names.

Figure (4-11): Conceptual graph of the sentence "**The dog scratches its ear with its paw**".
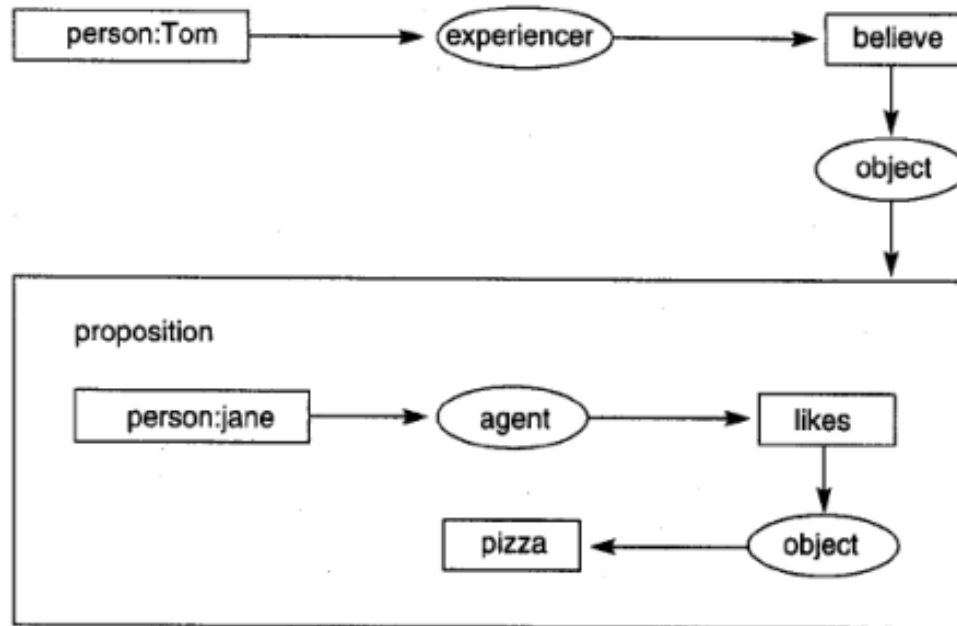

Figure (4-12): Conceptual graph of the statement "**Tom believes that Jane likes pizza**", showing the use of a propositional concept.
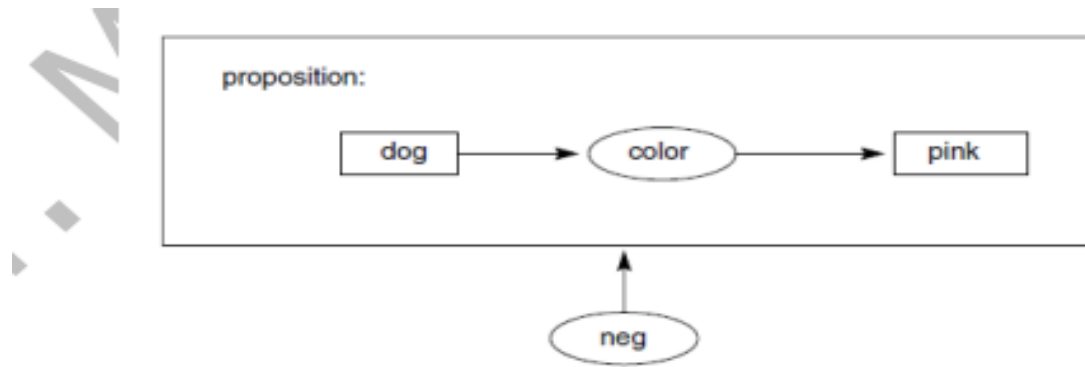
Figure (4-13): Conceptual graph of the proposition "**There are no pink dogs**".

Advantages of Conceptual Graph

- It offers a task analysis approach that is applicable to a wide variety of domains.
- It offers a systematic questioning methodology to infer complex knowledge.

Disadvantages of Conceptual Graph

- It is a complex task analysis method and take time to learn.
- It is expensive knowledge acquisition method.

2.7.   Frames

- A frame is a data structure that includes all the knowledge about a particular object.

- Knowledge organized in a hierarchy for diagnosis of knowledge independence.

- Form of object-oriented programming for AI and ES.

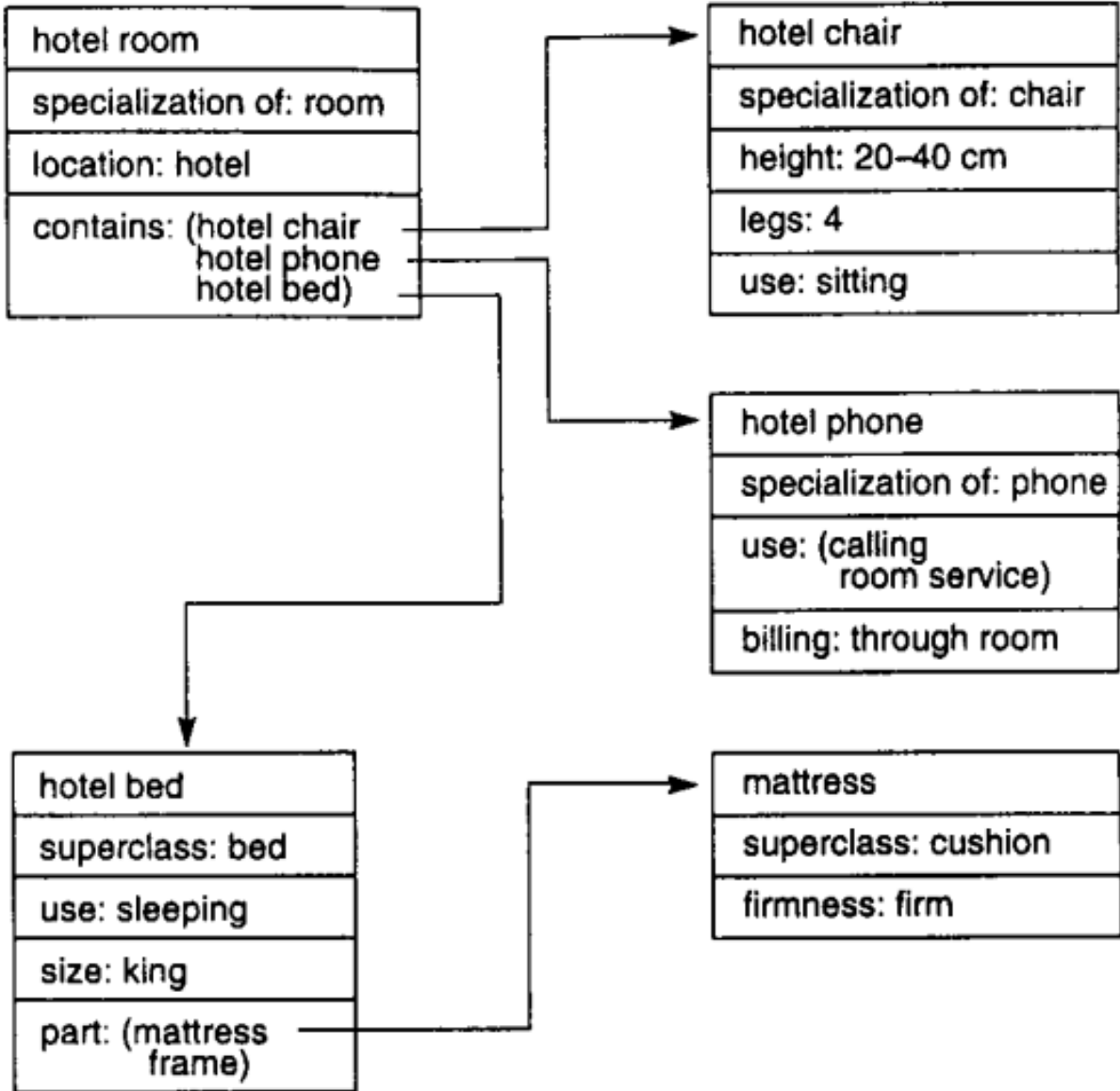- Each Frame Describes One Object

Organization of frames: -

1. A name.
2. Slots:- these are the propoerties of the entity that has the name, and they have values. Aparticular value may be:-
a) A default value.
b) An inherited value from a higher frame.
c) A procedure, called a daemon, to find a value.
d) A specific value, which might represent an exception.

Advantages of frames

1. Domain knowledge model reflected directly.

2. Support default reasoning.

3. Efficient

4. Support procedural knowledge.

Disadvantages of frames

1. Lack of semantics.

2. Expressive limitations

hotel room
specialization of: room
location: hotel
contains: (hotel chair 　　　　hotel phone 　　　　hotel bed)

hotel chair
specialization of: chair
height: 20–40 cm
legs: 4
use: sitting

hotel phone
specialization of: phone
use: (calling 　　　room service)
billing: through room

hotel bed
superclass: bed
use: sleeping
size: king
part: (mattress 　　　frame)

mattress
superclass: cushion
firmness: firm

2.8.   Scripts :-

A script is a structure that prescribes a set of circumstances which could be expected to follow on from one another. It is similar to a thought sequence or a chain of situations which could be anticipated.

The components of a script include:

1. Entry Conditions :- these must be satisfied before events in the script can occur.

2. Results :- Conditions that will be true after events in script occur.

3. Props :- Slots representing objects involved in events.

4. Roles :- Persons involved in the events.

5. Track :- Variations on the script. Different tracks may share components of the same script.

Advantages of Scripts:

1. Ability to predict events.
2. A single coherent interpretation may be build up from a collection of observations.

Disadvantages of Scripts:

1. Less general than frames.
2. May not be suitable to represent all kinds of knowledge.

Script: Restaurant
Track: Coffee Shop
Props: Tables, menus, food, check, money
Roles: Customer, cook, owner, waiter, cashier

Entry Conditions: Customer is hungry.
                       Customer has money.

Results: Customer has less money.
           Customer is not hungry.
           Owner has more money.

Scenes:

1. Entering
       Customer goes into restaurant.
       Customer looks around.
       Customer decides where to sit.
       Customer goes to the table and sits down.

2. Ordering
       Customer picks up menus.
       Customer decides on food.
       Customer orders food from waiter.
       Waiter tells cook the order.
       Cook prepares food.

3. Eating
       Cook gives food to waiter.
       Waiter gives food to customer.
       Customer eat food.

4. Exiting
       Waiter writes out check.
       Waiter brings check to customer.
       Customer gives tip to waiter.
       Customer goes to cash register.
       Customer gives money to cashier.
       Customer leaves restaurant.