Syllabus

Module 1(1) Introduction: Intelligence, Foundations of artificial Intelligence(AI), History of AI, Agents and Environments, Rationality of Agents, Nature and Structure of Agents, Communication among agents.

Module 1(2) Problem formulation and Solution: Problem types, states and operators, state space, Uninformed Search Strategies , Informed Search Strategies- Best first search, A* algorithm, heuristic functions, Iterative deepening A*(IDA), small memory A*(SMA).

Module 1(3) Game Playing: Perfect information game, imperfect information game, evaluation function, MiniMax algorithm, alpha-beta pruning.

Module 2(4) Applications: Areas of AI, Natural Language Processing, Case Study of Existing Expert Systems.

Module 1(4)Logical Reasoning: Inference in Propositional Logic, First order Predicate logic, Resolution, Logical Reasoning, Forward chaining, Backward chaining, Knowledge representation techniques: Semantic networks and frames.

Knowledge Representation

Inference in Propositional Logic, First order Predicate logic, Resolution, Logical Reasoning, Forward chaining, Backward chaining,

Knowledge representation techniques: Semantic networks and frames.

What is Knowledge Representation?

Knowledge Representation in AI describes the representation of knowledge. Basically, it is a study of how the **beliefs, intentions**, and **judgments** of an **intelligent agent** can be expressed suitably.

The different kinds of knowledge that need to be represented in AI include:

- **Objects**
- **Events**
- **Performance**
- **Meta-Knowledge**

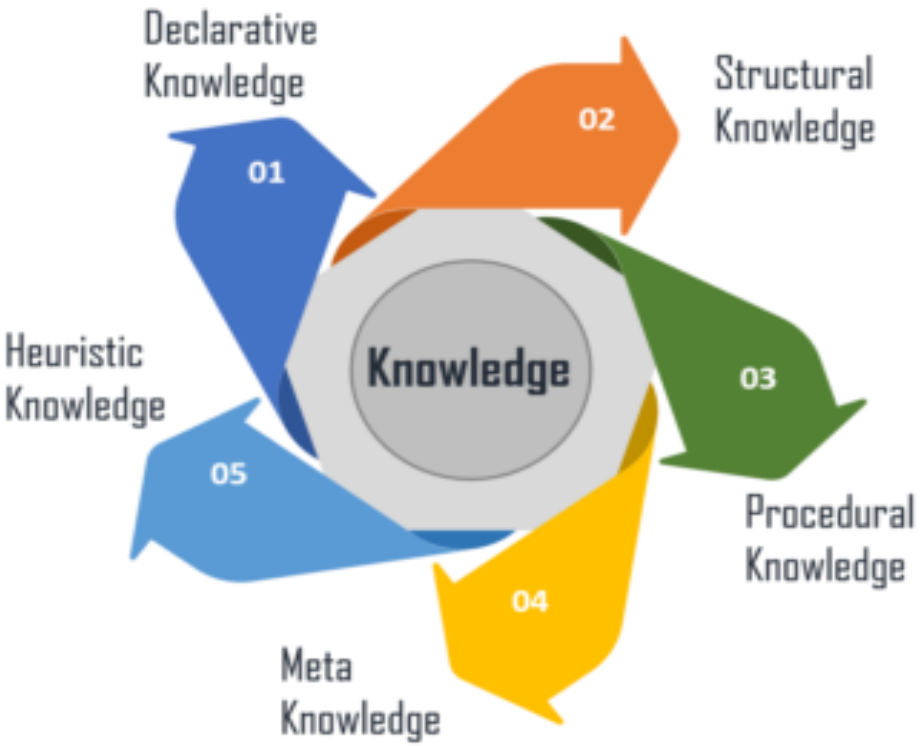
Objects -- Facts about objects in our world domain. e.g. Guitars have strings, trumpets are brass instruments.

Events -- Actions that occur in our world. e.g. John played the guitar in Zappa's Band.

Performance -- A behavior like playing the guitar involves knowledge about how to do things.

Meta-knowledge -- knowledge about what we know.

Different Types of Knowledge



Declarative Knowledge – It includes concepts, facts, and objects and expressed in a declarative sentence.

Structural Knowledge – It is a basic problem-solving knowledge that describes the relationship between concepts and objects.

Procedural Knowledge – This is responsible for knowing how to do something and includes rules, strategies, procedures, etc.

Meta Knowledge – Meta Knowledge defines knowledge about other types of Knowledge.

Heuristic Knowledge – This represents some expert knowledge in the field or subject.

Cycle of Knowledge Representation in AI

Artificial Intelligent Systems usually consist of various components to display their intelligent behavior. Some of these components include:

- Perception
- Learning
- Knowledge Representation & Reasoning
- Planning
- Execution

The **Perception component** retrieves data or information from the environment.

Then, there is the **Learning Component** that learns from the captured data by the perception component.

The main component in the cycle is **Knowledge Representation and Reasoning** which shows the human-like intelligence in the machines. Knowledge representation is all about understanding intelligence.

The **Planning and Execution** components depend on the analysis of knowledge representation and reasoning. Here, planning includes giving an initial state, finding their preconditions and effects, and a sequence of actions to achieve a state in which a particular goal holds. Now once the planning is completed, the final stage is the execution of the entire process.

Techniques of knowledge representation

There are mainly four ways of knowledge representation which are given as follows:

1. Logical Representation
2. Semantic Network Representation
3. Frame Representation
4. Production Rules

Logical Representation

Logical representation is a language with some **definite rules** which deal with propositions and has no ambiguity in representation.

It represents a conclusion based on various conditions and lays down some important **communication rules**.

It also consists of precisely defined **syntax and semantics** which supports the sound inference. Each sentence can be translated into logics using syntax and semantics.

Syntax:

- Syntaxes are the rules which decide how we can construct legal sentences in the logic.
- It determines which symbol we can use in knowledge representation.
- How to write those symbols.

Semantics:

- Semantics are the rules by which we can interpret the sentence in the logic.
- Semantic also involves assigning a meaning to each sentence.

Logical representation can be categorized into mainly two logics:

- **Propositional Logics**
- **Predicate logics(First Order PL)(Predicate Calculus)**

Semantic Network Representation

Semantic network is a knowledge representation model which is in a form of graphical schemes consisting of nodes and links among nodes.

Nodes in a semantic network can show concepts, objects, features, events, time, and also links indicating the connection among nodes.

The links should be labeled and directed. As a result, **semantic net refers to a directed diagram or associative nets.**

Types of relationships in semantic network

1) The “is-a” relationship between class and superclass (Figure 1);

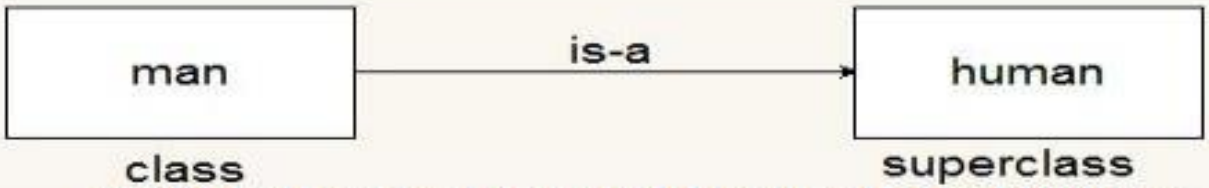


Figure 1: The “is-a” relationship between class and superclass

2) The “is an instance of“ relationship between instance and class (Figure 2);

Figure 2: The “is an instance of“ relationship between instance and class

3) The "is a part of" relationship between part and whole (Figure 3);

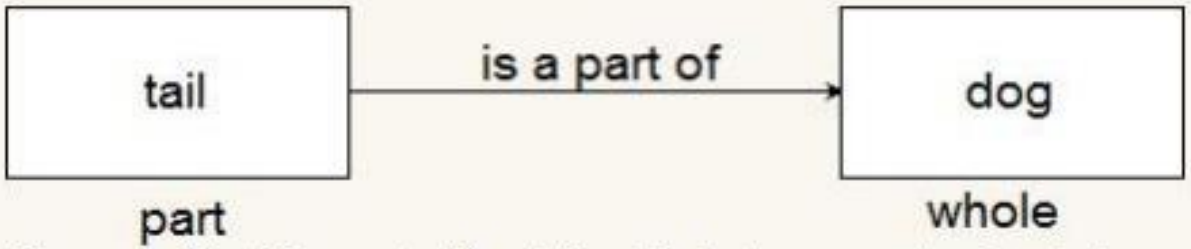


Figure 3: The "is a part of" relationship between part and whole

4) The "has" relationship between object and attribute (Figure 4).

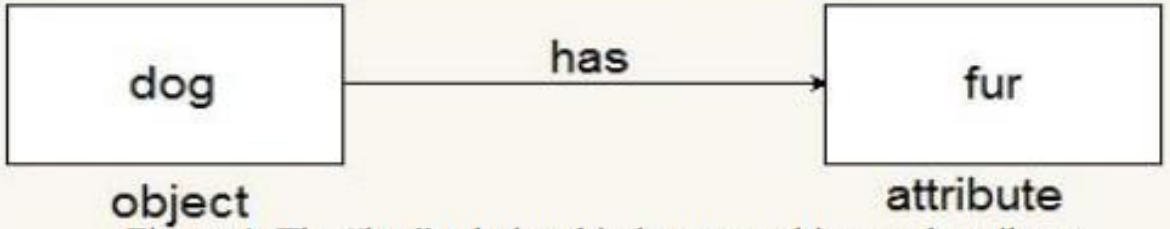
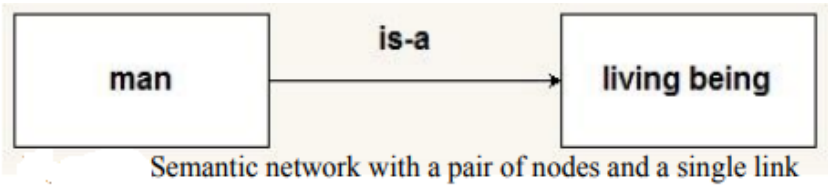
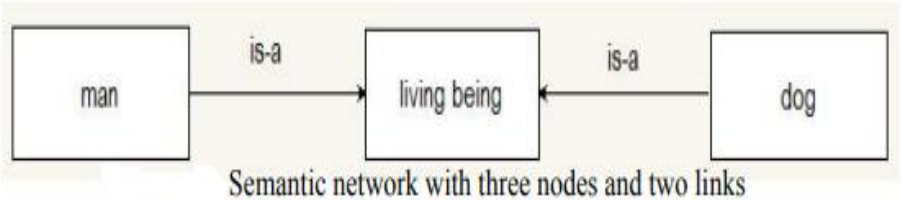


Figure 4: The "has" relationship between object and attribute

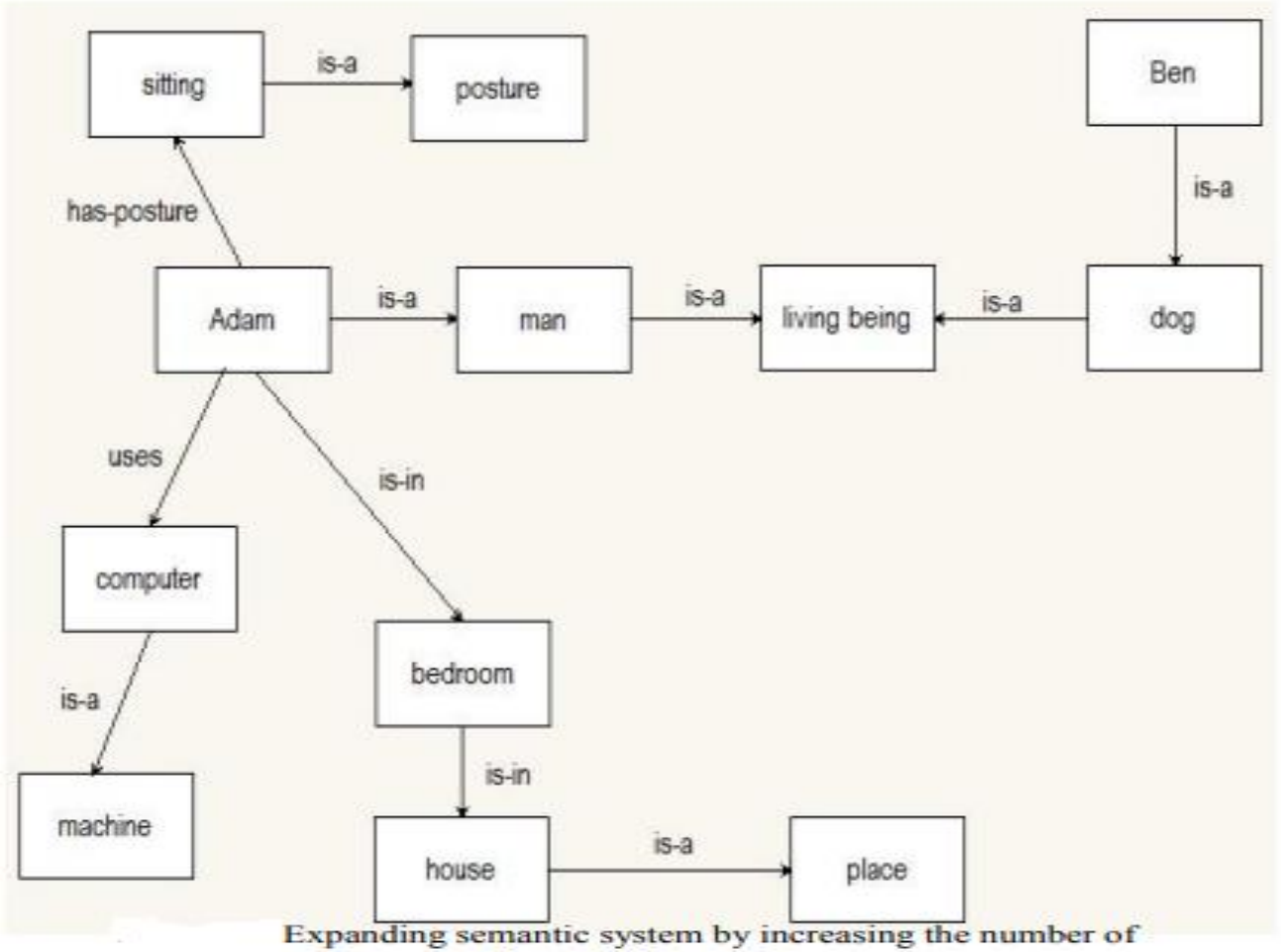
Examples of Semantic Network



Semantic network with a pair of nodes and a single link

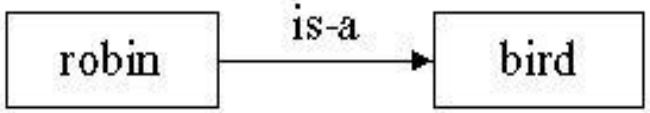


Semantic network with three nodes and two links

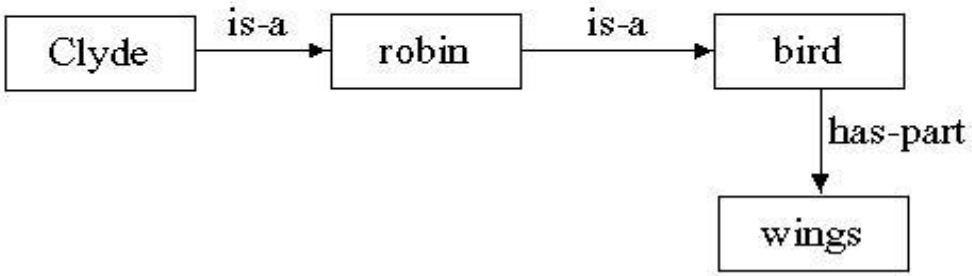


Expanding semantic system by increasing the number of nodes and class nodes

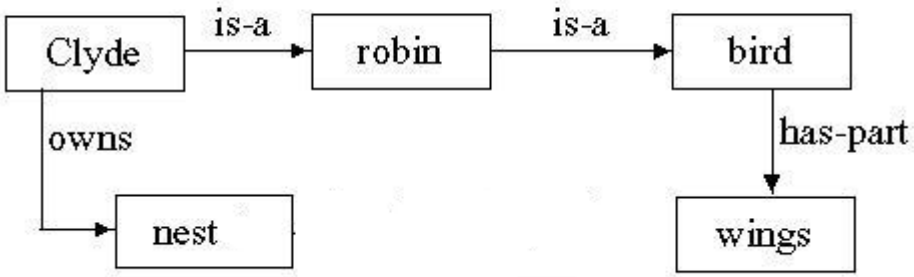
Example: All robins are birds



adding (1) Clyde is a robin
(2) birds have wings

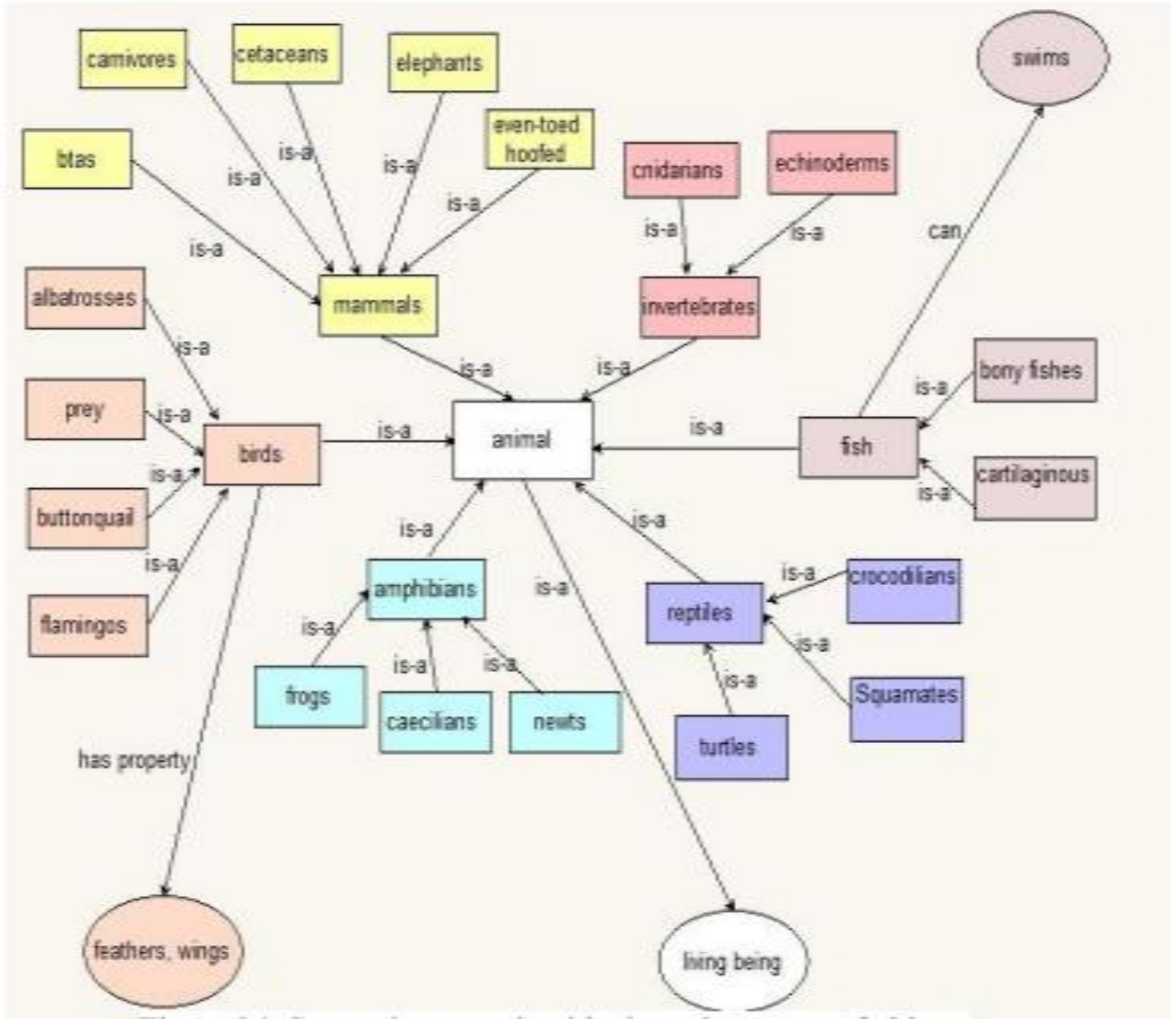


Clyde owns a nest:



1. Scientific researches about animals show that there are six main groups of animals including birds, mammals, amphibians, invertebrates, reptiles, and fishes. The group of birds includes albatrosses, prey, buttonquail, and flamingos. The group of mammals includes bats, carnivores, cetaceans, elephants, and even-toed hoofed. The group of amphibians includes frogs, caecilians, and newts. The group of invertebrates includes cnidarians and echinoderms. The group of reptiles includes crocodilians, squamates, and turtles. The group of fishes includes bony fishes and cartilaginous. The birds have feathers and wings, fishes can swim.

   Design semantic network for these six groups.


carnivores
cetaceans
elephants
even-toed hoofed
bats
cnidarians
echinoderms
swims
is-a
can
albatrosses
mammals
invertebrates
bony fishes
prey
animal
fish
cartilaginous
birds
buttonquail
flamingos
amphibians
crocodilians
reptiles
frogs
caecilians
newts
Squamates
turtles
has property
feathers, wings
living being

Frame

A frame is a **record like structure** which consists of a collection of attributes and its values to describe an entity in the world.

It consists of a collection of **slots and slot values**. These slots may be of any type and sizes.

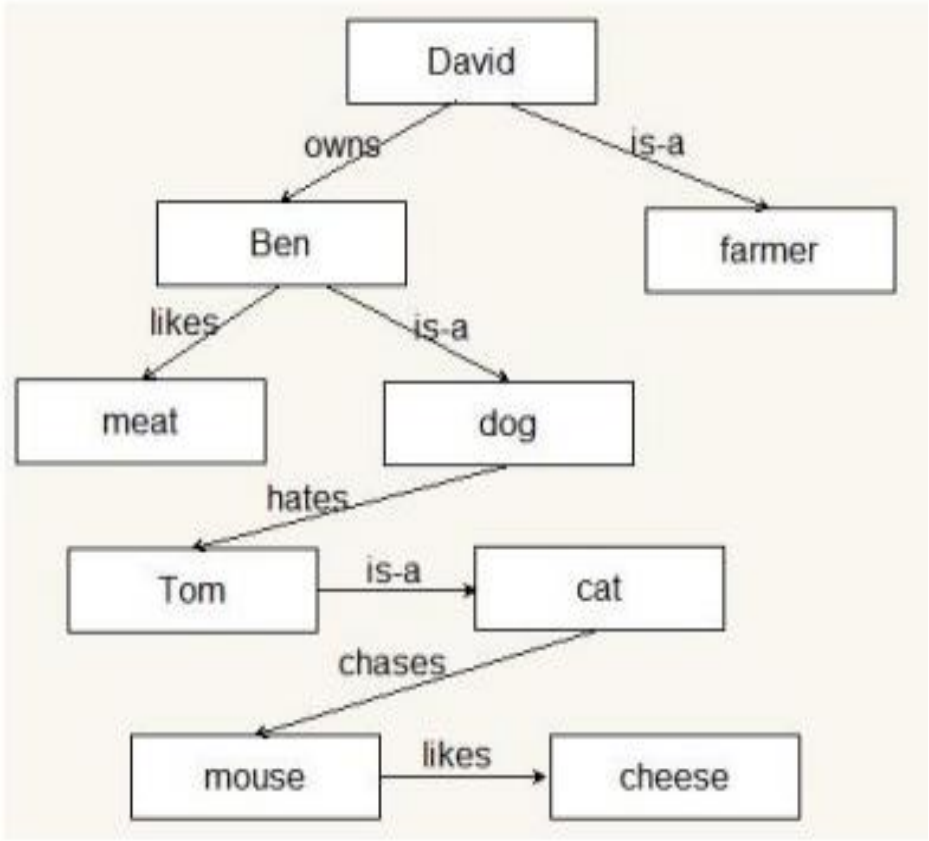
Slots have names and values which are called **facets.**

A frame may consist of any number of slots, and a slot may include any number of facets and facets may have any number of values.

A frame is also known as **slot-filter knowledge representation** in artificial intelligence.

Semantic network is represented in the form of frame

Every frame provides a number of slots which are designated as slot values. Instead of simply processing links among frames, every relationship is indicated by away from a value being put into any slot.



Frame name	Slot	Slot values
David	is-a	farmer
	Owns	Ben
	Likes	meat
Ben	is-a	dog
	Hates	Tom
Tom	is-a	cat
	Chases	mouse
Mouse	Likes	cheese

Representation of semantic network in the form of frame

The frame is just like a record construction and related to the fields and values which are generally slots as well as slot fillers.

Slots	Fillers
Title	Artificial Intelligence
Publisher	Jones and Bartlett
Author	Ben Coppin
Edition	1st
ISBN	0-7637-3230-3
Pages	768
Year	2004

Frame example of the book "Artificial Intelligence"

1. Create a frame for personal data.

Slot	Filler
Name	Ahmed Murat
Job	Teacher
Gender	Male
Height	178 cm
Weight	78 kg
Marital status	Single
Intelligence	High

Production Rules

In production rules, agent checks for the condition and if the condition exists then production rule fires and corresponding action is carried out.

The condition part of the rule determines which rule may be applied to a problem. Whereas, the action part carries out the associated problem-solving steps. This complete process is called a **recognize-act cycle.**

The production rules system consists of three main parts:

- The set of production rules
- Working Memory
- The recognize-act-cycle

Example:

- **IF (at bus stop AND bus arrives) THEN action (get into the bus)**
- **IF (on the bus AND paid AND empty seat) THEN action (sit down).**
- **IF (on bus AND unpaid) THEN action (pay charges).**
- **IF (bus arrives at destination) THEN action (get down from the bus).**