Semantic Network and Frame Knowledge Representation Formalisms in Artificial Intelligence

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ABSTRACT

Choosing a suitable method to represent the knowledge concerning the real world is one of the major issues involved in Artificial Intelligence.

The purpose of this research is to consider the important beneficial roles of semantic network and frame formalisms for knowledge representation in Artificial Intelligence. The basic properties of the above methods for appropriate structuring and arranging the knowledge are presented.

Some types of relationships, the conceptual graph, and the types of semantic network are described. The structure of frame-based system is given. The term class and instances are discussed.

Some examples of semantic networks and frames are represented. The advantages and disadvantages of both semantic network and frame techniques are considered.

Keywords: Artificial Intelligence, Knowledge representation, Semantic networks, Frames

ÖZ

Gerçek dünya ile ilgili bilginin temsili için uygun bir yöntem seçme yapay zeka'nın önemli konularından biridir.

Bu araştırmanın amacı, yapay zeka bilgi gösterimi için anlamsal ağ ve çerçeve biçimciliklerinin önemli rollerinin yararını tartışmaktır. En iyi yapılanma ve bilgi düzenlenmesi için yukarıdaki yöntemlerin temel özellikleri sunulur.

Anlamsal ağda ilişkilerin bazı türleri ve kavramsal grafik tanımlanır. Çerçeve tabanlı sistemin yapısı verilir.

Anlamsal ağlar ve çerçevelerin bazı örnekleri gösterilir. Anlamsal ağ ve çerçeve tekniklerinin avantajları ve dezavantajları tanımlanır.

Anahtar Kelimeler: Yapay Zeka, Bilgi gösterimi, Anlamsal ağlar, Çerçeveler

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Chapter 1

INTRODUCTION

Artificial Intelligence (AI) is a branch of computer science and engineering used in many areas, and has a relation with another intelligence known as human intelligence. AI helps machines think and act like human for solving complex problems, and takes characteristics from human intelligence to arrange them as an algorithm in a computer. AI also works with other fields such as biology, psychology, cognition, mathematics etc.

The history of AI belongs to past years, founded in 1956 at a conference on Dartmouth's campus. AI is important because of having ability to make a never-ending thought process. The goal of AI is to use computers by allowing them to control tedious or risky jobs instead of human, and to recognize human intelligence principles.

What is human intelligence? Human intelligence refers to the ability of combining several cognition processes to make them suitable to the environment. A human intelligence is a power of human mind to learn from the expertise, to conform to a new situation, and to handle abstract ideas to manipulate one's environment.

There are some differences between human intelligence and AI. Human intelligence rotates around adjusting to nature's domain utilizing a blend of a few cognitive courses of action. The field of AI concentrates on planning machines that can emulate the human behavior. Some people accept that strong AI is never conceivable because of the different contrasts between the human brain and a personal computer. Thus, at the time, the mere capability to mimic the human behavior is acknowledged as AI.

The people are surrounded by a large amount of knowledge used to understand the world, to reason logically, to make conclusions and decisions, and to build a communication with others.

The knowledge representation was playing a very significant role in the development process of AI. The knowledge representation is a subarea of AI dealing with designing and implementing methods of the knowledge for its representation in computer, and the knowledge can be used to derive more information about the problem. The appropriate choice of the knowledge representation method is basically defined by easy use, effective manipulation and extension of knowledge that can make the intelligent system to perform optimal.

The knowledge representation is devoted to showing information about the world in a signifier that computer system can use to solve problems like diagnosing a medical condition or having a conversation between two persons in a natural language. The knowledge representation integrates finding psychology about how the problems can be solved, and the knowledge is represented so as to design formalisms that try to make easier the complex systems to design. The knowledge representation and reasoning incorporate discovering from the logic to automate different kinds of reasoning, for example, the application of rules or the connection of sets and subsets.

In this thesis two types of knowledge representation formalisms are considered: semantic network and frame.

Semantic network or semantic net was proposed by Quillian in 1967 in order to represent the knowledge in a form of graph. Semantic network is a technique of knowledge representation that is used for propositional information, and sometimes called a propositional net. In knowledge representation the semantic networks are two dimensional. In terms of mathematics a semantic network is defined as a labeled directed graph. The semantic network is composed of links, nodes and link labels. In the diagram the semantic network nodes are described as ellipses, circles or rectangles to show objects such as physical objects, situations or concepts. The links can be used to express the relationships between objects. A particular relation is specified by link labels. The basic structure of knowledge organizing is provided by relationships.

There are some historical roots about semantic networks and frames, and one of them is linguistic syntax and semantics, in particular the Fillmore’s grammar case.

The idea of a frame was presented by M. Minsky in 1975. The case frame in a situation of grammar was taken to define a small scene abstract that identifies the member of the scene. Therefore the arguments of predicates and the scene are described by sentences. The sentences the users of language suppose are to have psychological access to schematized scene. The frame knowledge representation method is highly structured that collects information about specific events and objects to arrange both into the taxonomic structure comfortable from biological taxonomies.

Frame is a data structure from AI used to divide the knowledge into some parts by representing stereotyped situations. Frames were expected from semantic networks, and the frame can be used for such AI applications as vision and natural language processing. Sometimes a single frame is not much beneficial. The frame systems have a collection of frames related to each other.

Chapter 2

REVIEW OF EXISTING LITERATURE ON SEMANTIC NETWORK AND FRAME KNOWLEDGE REPRESENTATION FORMALISMS

In [1] an independent way is used for extracting semantic networks from the huge amount of text. The Text Runner system is used for obtaining the tuples from text and producing general idea and connections from them by mutually clustering objects and relational strings in the rows. The proposed approach is defined using Markov model by considering four rules. The experimental results show that the performance of the proposed approach to be applied to the real-world web dataset is significantly better than the performances of other three relational clustering approaches, and the new approach is more appropriate for extracting reasonable semantic networks.

To structure the meaning, one of the necessary knowledge representation models is semantic network. [2] presents the implementation principles of semantic network. The significance of AI languages as well as object-oriented programming languages in the practical implementation process of semantic network is discussed. The semantic network based on combination of graph theory, graph-grammar theory, and order theory can represent better performance.

In [3] the author proposes a transformation process of semantic network knowledge representation method into frame knowledge representation technique which is more suitable to be used for decision support systems. To use the proposed transformation result a test system is produced which generates frame structure from the related semantic networks as data to the test system in order to develop a simulator.

In [4] semantic model framework for knowledge representation in autonomous underwater system is developed. The advantage of the framework in a real situation is analyzed. A hardware error is demonstrated in a REMUS 100 AUV while carrying out a mission. The proposed framework can be successfully applied to both land and air robotics.

The large difference in representations, levels of knowledge and available episodes causes a big problem in using semantic information in the form of video. In [5] the integration of the image description with multi-level semantic network for the baseball video interpretation is described. The classical image understanding is formulated using a low-level knowledge while a high-level human perceptual knowledge is used for encoding the information.

In [6] the intelligent tutoring system is represented. The new Tutor-Expert System is demonstrated in which the knowledge is represented using semantic networks with frames and production rules. This system demonstrates the knowledge via semantic networks with frames and rule of creation.

[7] discusses the knowledge representation based on semantic networks with the high-level structure of frames. The proposed system is used for natural language system in order to obtain the correct senses of ambiguous words. The system is also appropriate for multiple subparts and entities.

A new idea of knowledge representation called Cognitive Representation Theory (CRT) is suggested in [8]. In this idea the semantic network, frame, semantic frame and conceptual dependency representation are put together. The implementation of the absolute/aspectual distinction instead of frame/slot distinction for natural language relationships is considered, and this idea is used in some AI systems.

In [9] the possibility of using RDF, XML, KIF, frame-CG (FCG) and Formalized-English for knowledge representation is discussed. The proposed high-level notations are helpful to improve the readability and to provide a normalizing effect for the knowledge. The documents to be used by the developers for making some notations and logical inferences can be taken into account to represent the knowledge.

The semantic network knowledge representation method is also known as an effective tool for natural language understanding. In [10] proposed knowledge representation method based on Sanscrit semantic network uses linguistic case frames. The representation model can be used for machine translation process.

In [11] the representation language for the first order predicate calculus (FOPC) is presented in order to formalize the knowledge retriever by designing a semantic network.

The inference mechanism in semantic network method is effective in presence of changing of information or adding new information into the system. In [12] the semantic network representation for demonstrating the encapsulation of groups, roles and other information for data interpretation is discussed. A network query language and a triggering system are presented to enrich the interactions for providing them to users.

Most systems and shells are based on production rules knowledge representation method. There are also systems in which the application of such knowledge representation formalisms as semantic nets and frames seems more appropriate. It is necessary to develop the approaches that verify the appropriateness of semantic nets and frames. This verification is important for knowledge acquisition, and is performed using both domain independent approaches to consider the characteristics of knowledge representation [13]. The knowledge base is examined for consistency, redundancy, and completeness after the verification approaches are implemented.

The standard knowledge representation languages cause many problems while dealing with large amount of data changing rapidly. The frame data model regarding denotational semantics methodology uses a subset of META IV [14].

Some semantic integrity limits are drawn after presenting few fundamental ideas of the model which finally causes the configuration of some processes in the frame data model.

The determination of the convenient approach to structure meaning has been an actual problem for many years from semantic field approach to semantic frame form. The common principles of both approaches as well as differences between them are discussed in [15].

In [16] the authors describe three kinds of semantic networks: WorldNet, Roget's Thesaurus, and World associations. They have a little world construction characterized by an adequate integration, short normally way lengths between words, and potent local clustering. Likewise the appropriations in the amount of associations take after force laws that demonstrate a scale-free shape of relations with numerous associations.

The approach for visual text analytics is used to support knowledge building and reasoning [17]. The semantic network models using k-next neighborhood method are described. The basic elements are presented to analyze the semantic network, and to describe the strategies of exploration.

The methodology for designing and construction of frame-based Multilingual Lexical Databases (MLLDSs) is presented in [18]. The author uses FrameNet database for English to show that its semantic frames can be used to create lexicon fragments for such languages as German, Japanese, and Spanish. In order to create frame-based MLLDSs, three steps are realized: the identification process of translation equivalents attestation, the semantic annotation of translation equivalents, and the creation of parallel lexicography.

The semantic network ConceptNet represents the project called Open Mind Common Sense [19]. The advantage of the network ConceptNet 3 is its easy adaptation to different languages. The content of ConceptNet 3 is evaluated, and its difference from WordNet natural language processing resource is represented.

The principles of Conceptual Vector Model are given in [20] to define how the cooperation between the conceptual vectors and semantic networks is realized to demonstrate the hyperonymy within the vector-based frame intended for semantics. The measures for the hyperonymy representation in a more accurate form are provided.

There are two types of knowledge representation models: declarative and procedural. The comparisons between predicate logic, semantic network, and frame declarative knowledge representation models are analyzed in [21]. The advantages and disadvantages of each knowledge representation method are discussed. The combination of above-mentioned methods provides better performance of the system, and improves the knowledge representation.

The meaningful frame-semantic parsing in unsupervised technique form is induced in [22]. The both quantitatively and qualitatively accesses for model performance are discussed.

Frame-based representation of knowledge is a powerful tool for a large complex domain, but the inability of dealing of this formalism with uncertainty and noise limits its advantage. At the same time, the Bayesian network is a very effective tool in dealing with uncertainty, but its disadvantage consists in handling a complex domain. In [23] proposed language provides the integration of advantages of both approaches in order to increase the inferential ability of the systems by expressing meaningful knowledge.

Chapter 3

SEMANTIC NETWORK KNOWLEDGE REPRESENTATION FORMALISM

3.1 Basics of semantic network

Natural language is quite effective without any attempt that permits us, for example, to ask someone how to get the nearest supermarket, to talk about our knowledge in order to show each of our opinion in relating to something. As a simple case, let's take a look at the following sentences:

1) Hary owns a cat.

2) Cat scares Jane.

Each of the above sentences is in the same type “Subject-verb-object” which is one of the easiest suitable grammatical structures. All these phrases represent some details. The words “Hary” and “Jane“ refer to particular persons, the word “cat” describes the type of mammalian, and the words “scare” and “owns” define the connection between the particular person and the pet under consideration. Since we realize by prior experience precisely what the actual verbs “owns” and “scare” indicate and we now probably noticed the pet before, we are able to understand both of sentences. After looking at them, we are able to say we are including new information about the entire world. That is a simple example associated with semantics: things and ideas can be referred as a symbol and series of symbols showing meaning. Now by using the meaning that we get from both of sentences, we can reply any simple questions. For example: “Who is the owner of this cat”?

Semantic network is a knowledge representation model which is in a form of graphical schemes consisting of nodes and links among nodes. Semantic networks of computer executions have been first developed with regard to artificial intelligence and machine interpretation, however previous versions had always been found in psychology, philosophy, and linguistics.

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. In the graphical perspective, circles or boxes usually represent nodes, and the links are sketched as arrows or connectors among the boxes or circles. The network design indicates its meaning, based on which nodes are related to other nodes. In practice, we can define semantic network as a collection of binary relations with a collection of nodes; the system refers with a predicate logic with binary associations. Furthermore, semantic systems are simply redundancy-free, because they are not able to allow the duplication from the same node.

3.1.1 Types of relationships in semantic network

There are many types of relationships that can be used in semantic networks. The following are four of them.

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

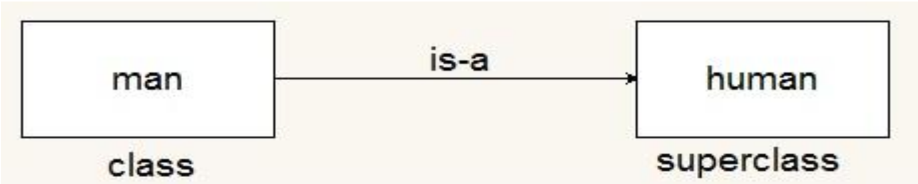


Figure 1: The “is-a” relationship between class and superclass

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

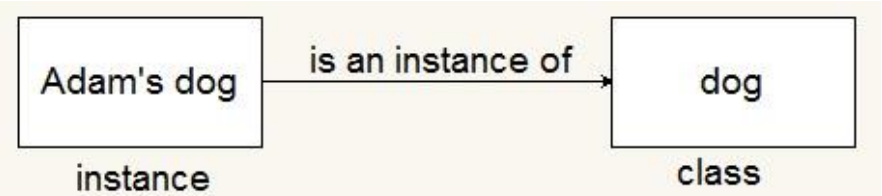


Figure 2: The “is an instance of“ relationship between instance and class

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

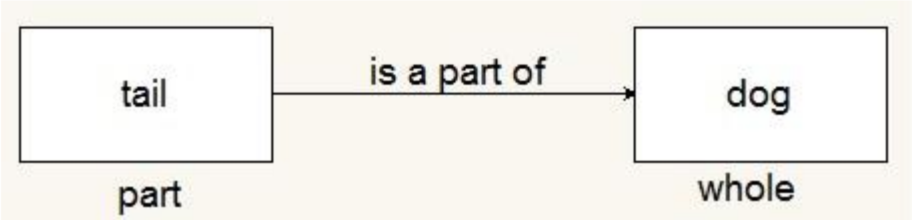


Figure 3: The “is a part of“ relationship between part and whole

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

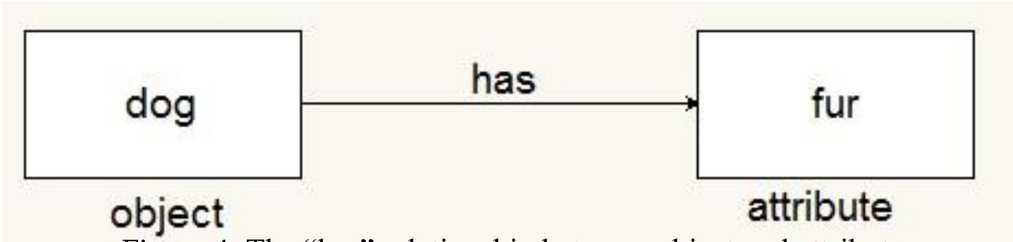


Figure 4: The “has” relationship between object and attribute

3.1.2 Semantic network inheritance

The inheritance is the interface of semantic network or is a procedure in which the local knowledge of a node superclass is referred by class node, instance node, and superclass node. In figure 5 an example about inheritance is given in which a man inherits the attributes of human - name and age.

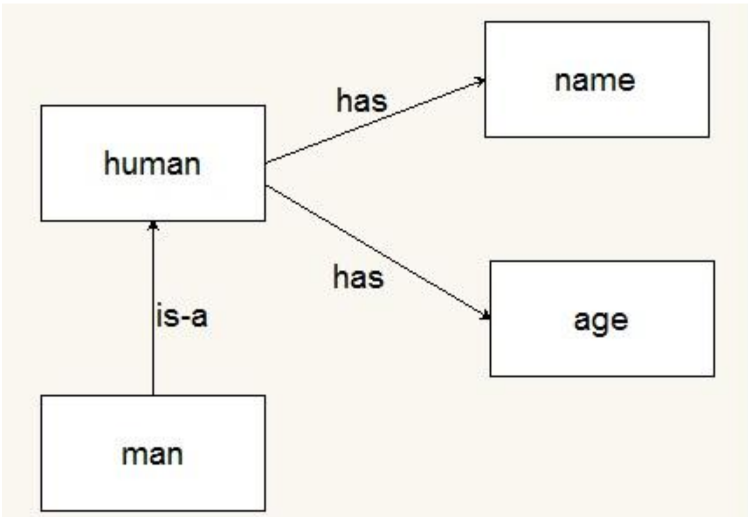


Figure 5: Inheritance of semantic network

3.1.3 Object-attribute-value (OAV) triplets

This is a general way that is used for many non-artificial intelligence database representations known as object-attribute-value sometimes referred to (OAV) triplets. The OAV triplets with three components are shown in figure 6.

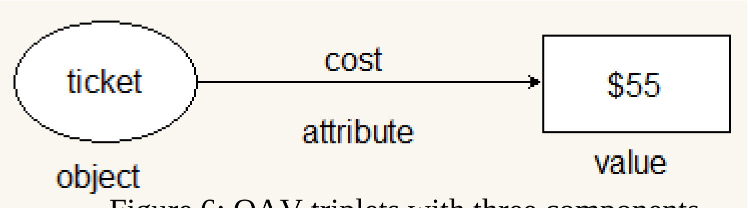


Figure 6: OAV triplets with three components

The OAV triplets can have one or more attribute values which are called multiple attribute values (Figure 7).

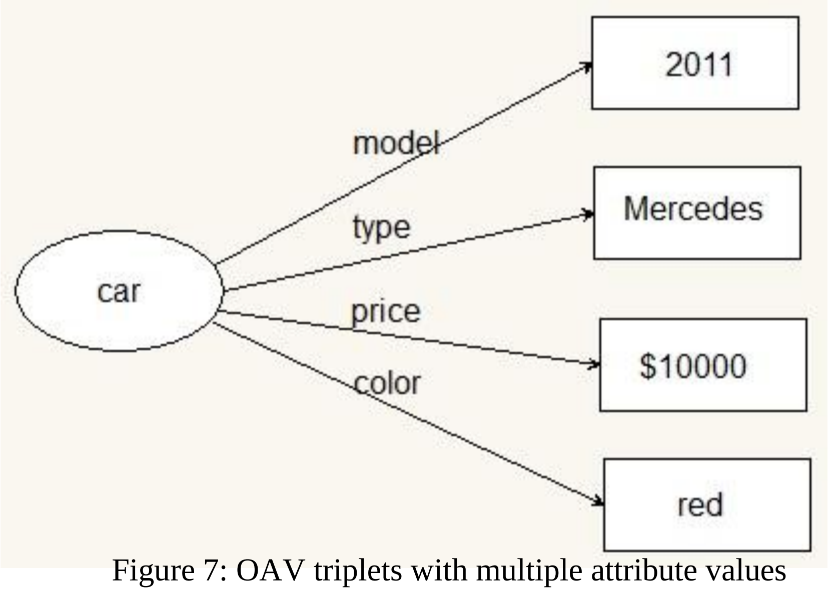


Figure 7: OAV triplets with multiple attribute values

3.2 Conceptual graph

The conceptual graph is very important to represent knowledge. John F. Sowa in 1976 used the conceptual graphs for conceptual schema that is used in database structure. The conceptual graph can be connected, finite and bipartite graph.

There are two kinds of nodes that can be used in conceptual graph - one of them is "concept" and the other is "conceptual relationship" represented in figure 8.

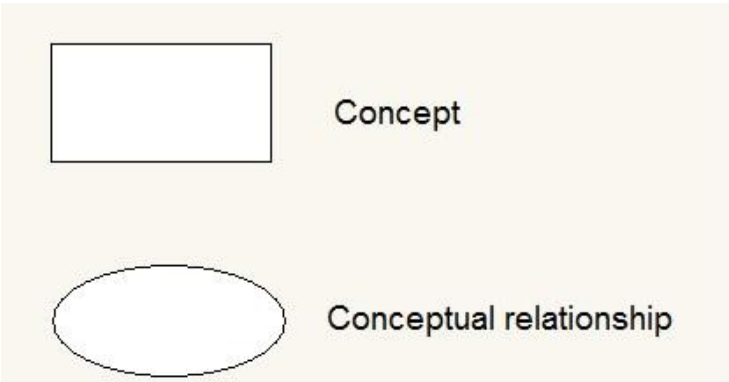


Figure 8: Concept and conceptual relationship nodes

3.2.1 Conceptual graph arcs

There are some arcs used in a conceptual graph:

1) One of the arcs is used to describe the relationship between concept and conceptual relationship (Figure 9);

Figure 9: The arc that links a concept to a conceptual relationship

2) Another arc is linking a conceptual relationship to concept (Figure 10).

Figure 10: The arc that links a conceptual relationship to a concept

At the same time some arcs are not permitted to be used in a conceptual graph:

- Between two concepts (Figure 11);

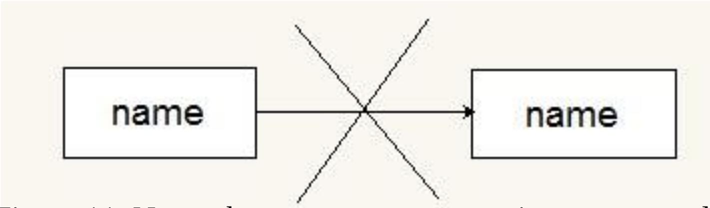


Figure 11. No arc between two concepts in a conceptual graph

- Between two conceptual relationships (Figure 12).

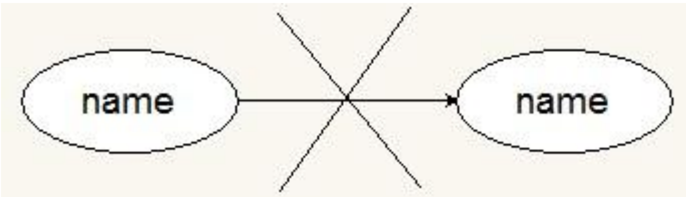


Figure 12. No arc between two conceptual relationships in a conceptual graph

Each relation in a conceptual relationship has a type and its nonnegative integer (n) known as a valence. A conceptual relation associated with a valence (n) is considered to be n-adic. For example, the 2-adic relation consists of single input and single output arcs (Figure 13).

Figure 13: The 2-adic relation

The 3-adic relation consists of two inputs and one output arcs (Figure 14).

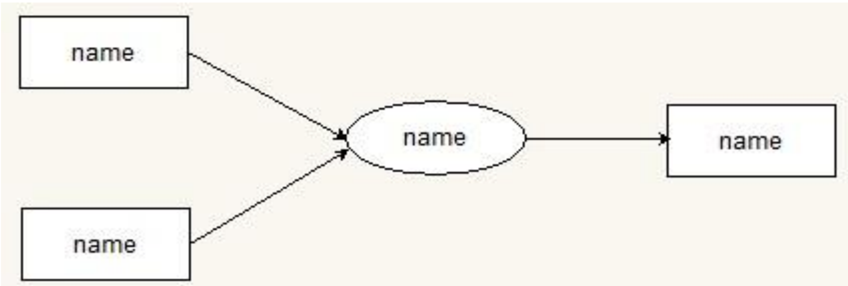


Figure 14. The 3-adic relation

3.2.2 Disjunctive and conjunctive semantics in conceptual graph

The disjunctive semantic in a conceptual graph is defined in terms of OR operation (Figure 15).

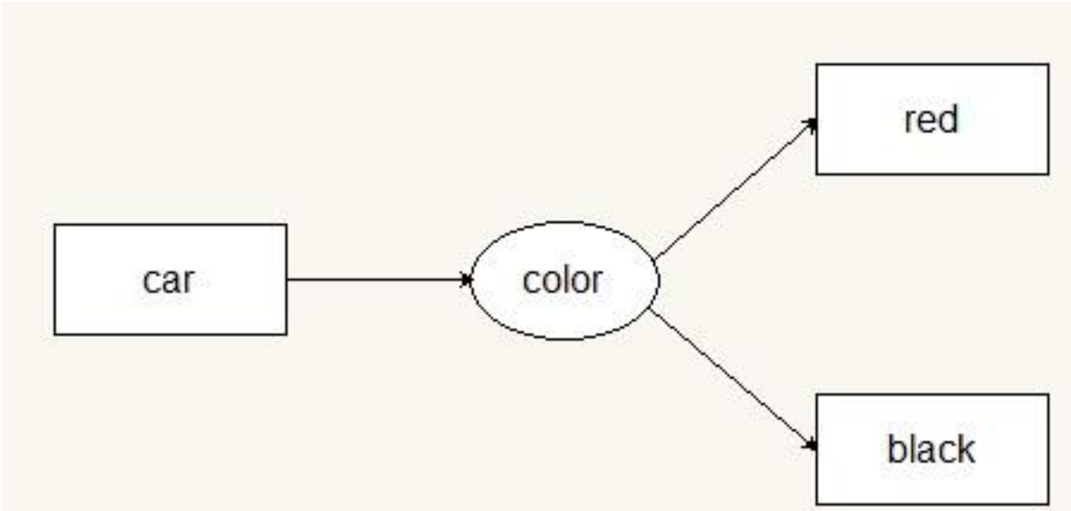


Figure 15: The disjunctive semantic in a conceptual graph

The conjunctive semantic in a conceptual graph is defined in terms of AND operation (Figure 16).

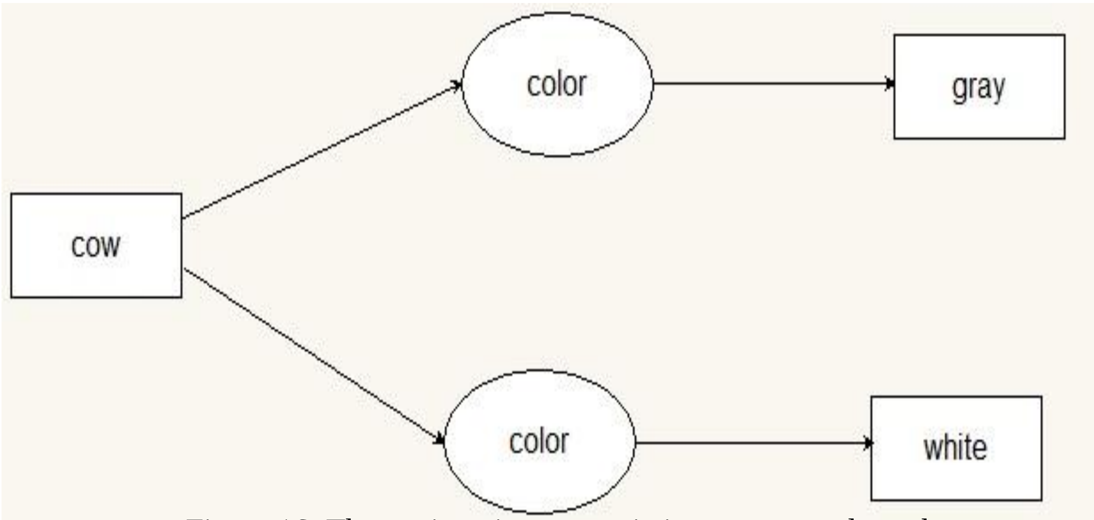


Figure 16: The conjunctive semantic in a conceptual graph

3.3 Understanding semantic networks

We can illustrate a semantic network by using some examples and representing its semantic system. In figure 17, a pair of nodes connected with a single link is represented. We can see that the left node labeled with “man“ is connected to the node on the right labeled with “living being”. The link between two nodes is labeled with “is-a “. The semantic network describes a ”man” such as an instance of “living being”. In fact, speaking technically, that structure represents the fact that there is a binary relationship among living being, such as man and the idea of man himself.

Figure 17: Semantic network with a pair of nodes and a single link

Figure 18 shows a semantic network consisting of three nodes and two links. This figure is close to the figure 17 by adding one more node named “dog” and a link labeled with “is-a” which is linked to the node “living being“. So the node “dog” is a type of “living being”.

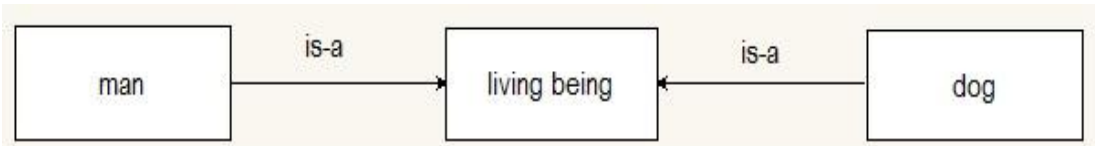


Figure 18: Semantic network with three nodes and two links

If the objects such as a man called “Adam” and a dog called “Ben” are added, and “Adam” owns “Ben”, the design of the network changes to another network as represented in figure 19. In this figure the link between the objects “Adam” and “Ben” is necessary so as to represent “Adam” owns “Ben” in fact this link is labeled with “owns”.

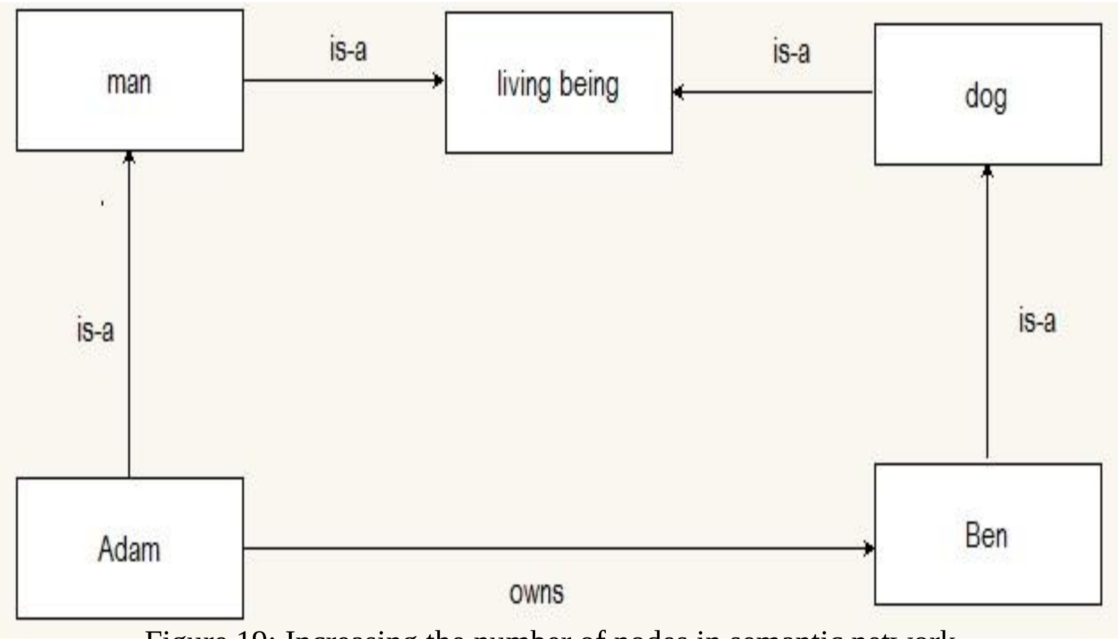


Figure 19: Increasing the number of nodes in semantic network

At this time it is very important to explain a point that may produce several semantic confusions. It is noticeable that the nodes belonging to that small system will not be the same kind. Certainly, the actual nodes classed “living being”, ”man” and “dog” stand for the universal or meta or class idea of a “living being”, a “man” and a “dog”, respectively. They only show abstract ideas. Alternatively, the objects “Adam” and “Ben” represent an individual of the objects “man” and “dog”, actually “Adam” is a man and “Ben” is a dog. Finally, it is important to see that we have two parts of context, and one of them is class, and another one is individual, but they may be represented in the same way.

Now, we add another class node with the name “place” that shows the actual abstraction associated with places within a category. Thus, another link labeled with “is-at” is added between the new object “house” and the object “Adam”, and also connecting the object “house” by using another link labeled with “is-a” between the nodes “house” and a “place”. The changes by adding some nodes and links are shown in figure 20.

By increasing the number of nodes, the meaning of the links should be considered. It is obvious that not all the links are the same. Certainly, several links show only the relation between objects, and for this reason the links depend on the nature of the statements for making the relationship between nodes. For instance, the link “is-at” in figure 20 shows the linking that the man “Adam” is at the place “house”. The knowledge is about the object itself, and it is not about the relation. It has a distinct kind of object, for example, the object “house” is a single example of the class node that is labeled with “place”.

In figure 19 some objects and links to the original graph were added. There is now an addition a class node labeled with “posture” with an instance object that is labeled with “sitting“. The relation link “has posture” expresses the knowledge that the person Adam has the “sitting” posture in the offered time. If we add another class node labeled with “machine” with one more node labeled with “computer”, it is an instance node, which is related to the man “Adam” by using the link “uses”. Afterwards a class node labeled with “room” and a particular instance labeled with “bedroom“ are added. At last we should add another link labeled with “is-in” which is used for linking the node “Adam” to the node “bedroom”, and the node “bedroom” links to the node “house” (Figure 21).

The system in figure 21 supplies a representation regarding to the knowledge about the nodes owned by it. For example, the man “Adam” is the owner of a dog “Ben”, and at the same time he is “sitting” in the “bedroom” and is using a “computer”. One more significant feature of the node - link rendering is the implied “inverse” of all connections represented by a link.

When there is a link going from one node to another one which indicates the inverse, meaning that the links from the second node belong to the first node.

In figure 22 we have two nodes labeled with “Adam” and “computer”, and the link labeled with “uses” depicting the path of the relation that “Adam” uses a “computer”. In practice, “Adam” is the subject and “computer” is the object, and “uses” is the verb of acting or link among them.

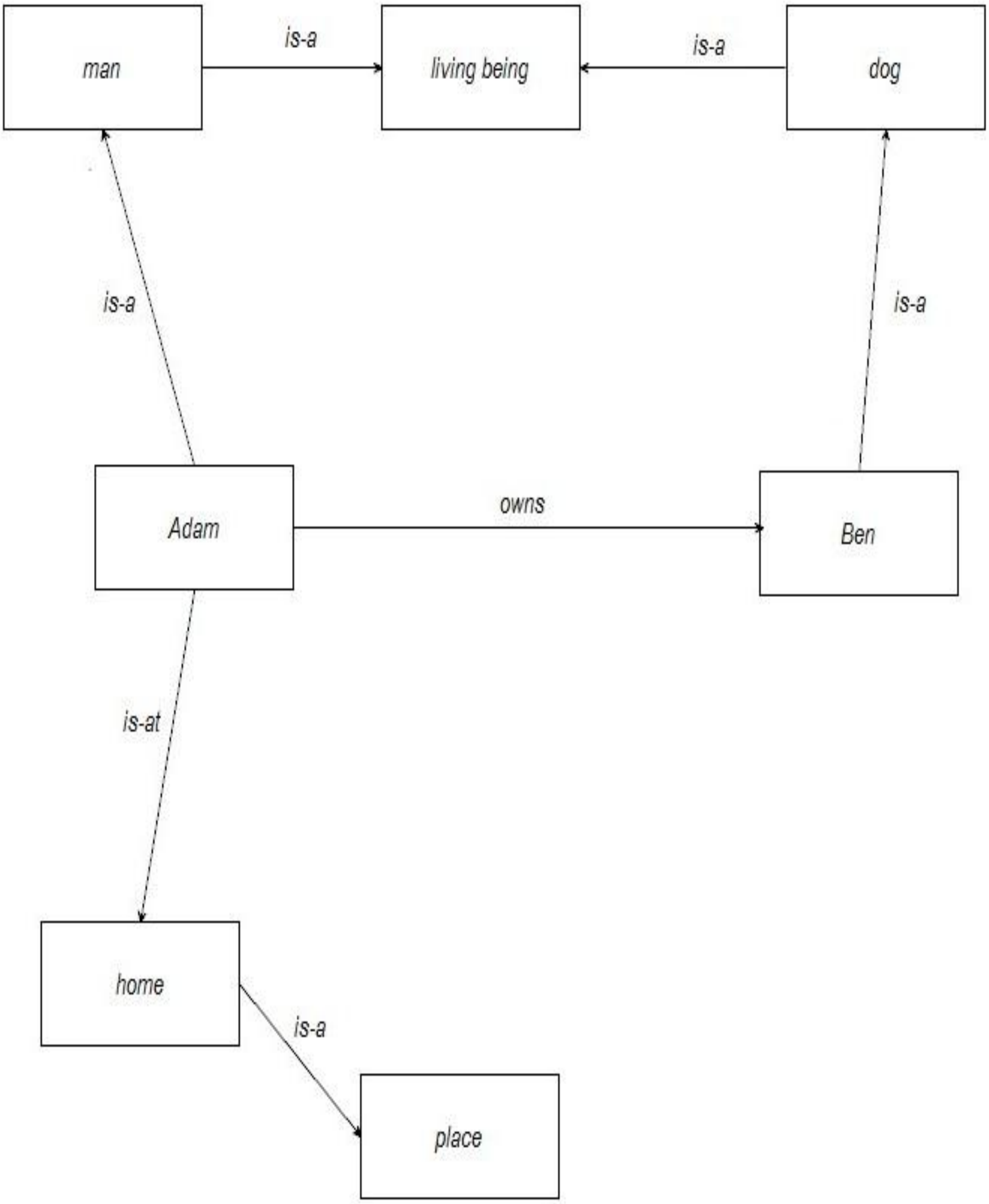


Figure 20. Expanding semantic network by increasing some nodes

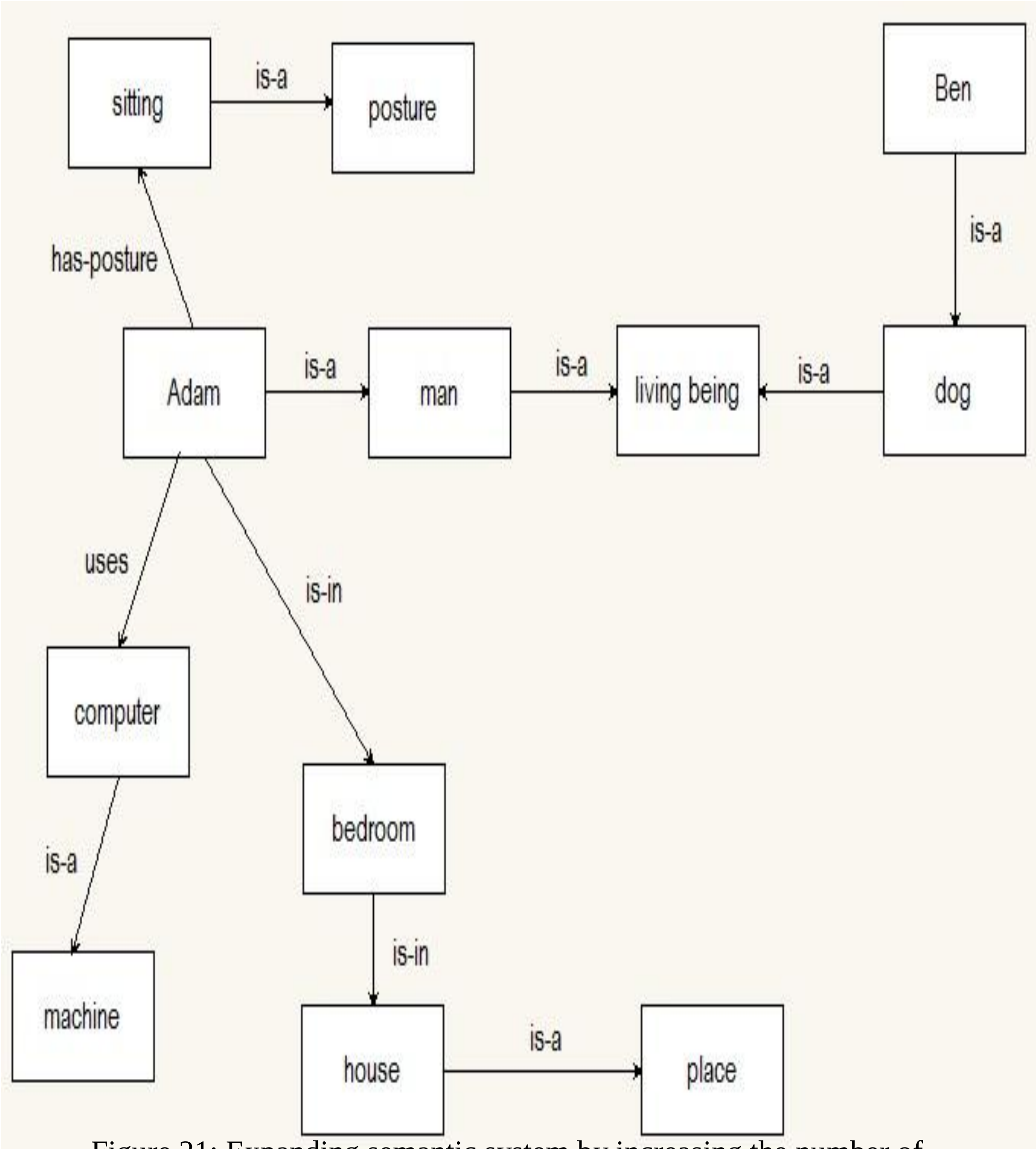


Figure 21: Expanding semantic system by increasing the number of nodes and class nodes

Figure 22: Two nodes with link depicting the path of relation

“Adam” uses a “computer” is the relation indicating the inverse relationship that “computer” is used by “Adam” (Figure 23).

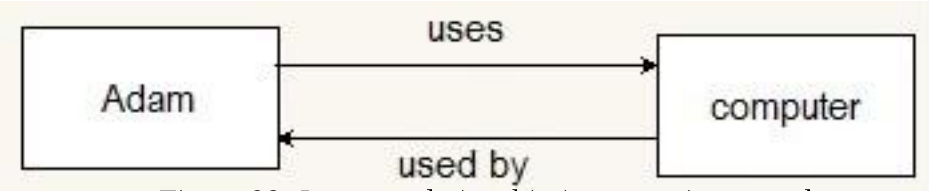


Figure 23: Inverse relationship in semantic network

The structure of a semantic network has three kinds of relationships:

1) Subclass relationship: this type of relationship can be written like “is-a kind of” or in another way as “is-a part of”;

2) Instance relationship: this type of relationship can be written as “is-an” or “is-a”.

3) Property relationship: this is one of the relations that is not subclass or instance, but a feature of an object.

3.4 Types of semantic networks

There are six most widely used types of semantic networks:

1) Definitional network deals with the relations between a newly defined subtype, and a concept type. A producing network is known as a generalization hierarchy. It supports the inheritance rule for duplicating attributes;

2) Assertional network is intended to state recommendations. The data in an assertion network is thought to be unexpectedly genuine, unless it is unequivocally marked with a modal administrator. Some assertion systems have been proposed as the model of the reasonable structures underlying the characteristic semantic natural languages;

3) Implicational network is used as the essential connection for associating nodes. They may be used to explain patterns of convictions, causality, or deductions;

4) Executable network incorporates some techniques, for example, such as attached procedures or marker passing which can perform path messages, or associations, and searches for patterns;

5) Learning network constructs or expands its representation by securing information. For example, the new information may change the old system by including and excluding nodes and arcs, or by changing numerical qualities called weights, and connected with the arcs and nodes;

6) Hybrid network has been clearly created to implement ideas regarding human cognitive mechanisms, while some are actually created generally for computer performance.

The difference between definitional and assertion systems, for instance, has a close up parallel to Tulving's (1972) difference between semantic storage and episodic storage. The linear notation and network notation are designed for indicating similar information. However, the specific types of information are generally simple to be expressed in one or another form. Considering that the boundary lines are uncertain, it is difficult to convey required and sufficient problems.

3.5 Semantic network components

We can specify a semantic network by indicating the basic components:

- Lexical component: nodes denoting physical objects; links are relationships between objects; labels denote the specific objects and relationships;

- Structural component: the nodes and links from a directed diagram;

- Semantic component: Definitions are related to the link and label of nodes. The facts will depend on the approval area;

- Procedural part: constructors permit a creation the new links and nodes. The destructors permit the removal of links and nodes.

3.6 Advantages and disadvantages of semantic network

As noticed, the semantic network is generally characterized by a superior representation as well as significant power which explains why many people make up a strong and adaptable approach to represent knowledge. The semantic networks have some advantages as given below:

1) Despite the variety of entities, they can be shown in the same semantic network;

2) Semantic systems supply a graphic view from the trouble place, and for this reason they may be simple to be implemented and easy to be understood;

3) Semantic network can be used as a typical connection application among various fields of knowledge, for instance, among computer science and anthropology;

4) Semantic network permits a simple approach to investigate the problem space;

5) Semantic network gives an approach to make the branches of related components;

6) Semantic network reverberates with the methods the people process data;

7) Semantic network is more natural than the logical representation;

8) Semantic network is characterized by a greater cognitive adequacy compared to logic based formalism;

9) Semantic network permits using of effective inference algorithm (graphical algorithm);

10) Semantic network has a greater expressiveness compared to logic.

Semantic network also provides a number of disadvantages that frequently cause problems. Some disadvantages are given below:

1) There is no difference between individuals and classes. The system is restricted by the user's knowledge of the definitions with the links in the semantic network. The links among nodes aren't most similar to functions. It is needed to distinguish the links which comprise a number of connections, and links which are structural in nature. The same links can be used to connect three nodes to show the structure of a network (Figure 24). Actually the link "is-a" is used in two different relationships - the first link labeled with "is-a" makes a relation between nodes "Ben" and "dog" that identifies that Ben is a dog, but in the second "is-a" relation the nodes "dog" and "living being" are connected to identify the category.

It is necessary to specify more descriptive method name of links differentiating concerning relational and structural types demonstrated in figure 25. In such cases we rewrite the link between nodes "Ben" and "dog" as a "type-of", and the link between the objects "dog" and "living being" as a "subtype-of" link.

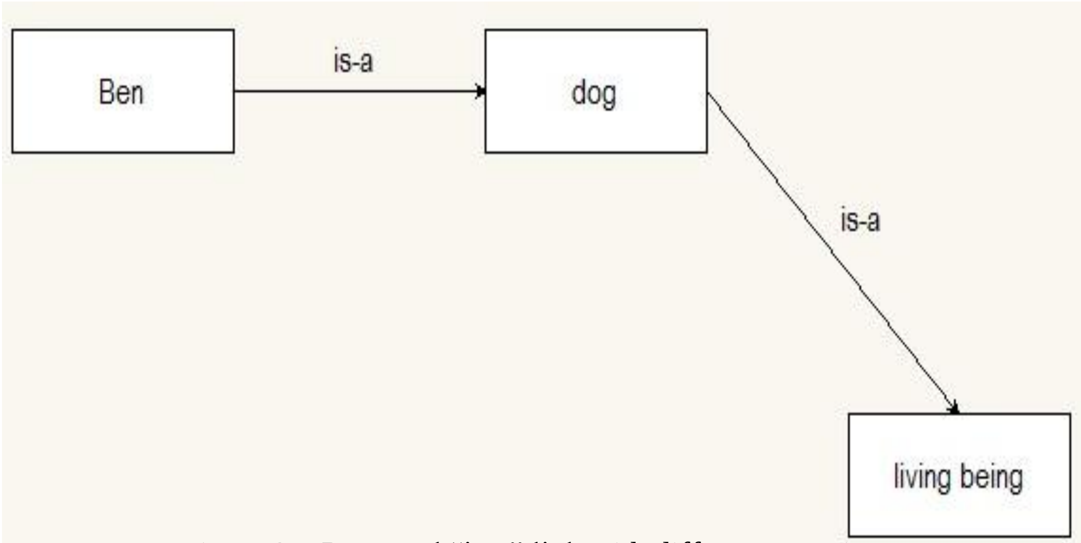


Figure 24: Repeated "is-a" link with different meanings

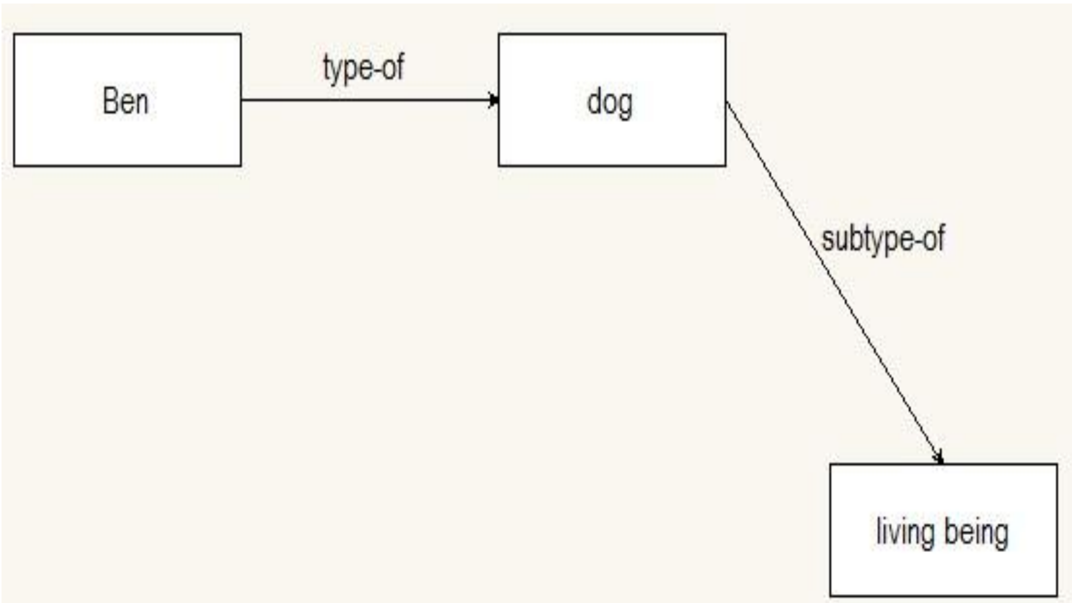


Figure 25: The "type-of" and "subtype-of" links

2) The difference between features related to a class and features comes from the individuals and from the class that doesn't exist;

3) A conventional semantic doesn't really exist; therefore there isn't an agreed-upon idea of what offered representational design indicates. The semantic systems are usually based upon the techniques that change them. An alternative to this problem could be both making use of conceptual diagrams, the formalism with regard to knowledge representation KL-ONE that allows conquering semantic indistinctness in the semantic system. KL-ONE is a popular knowledge representation system in semantic network and frame.

3.7 Examples with semantic networks

Let's consider more comprehensive examples with semantic networks.

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. A semantic network for these six groups is given in the figure 26.

Figure 27 depicts the example of combining different semantic network structures.

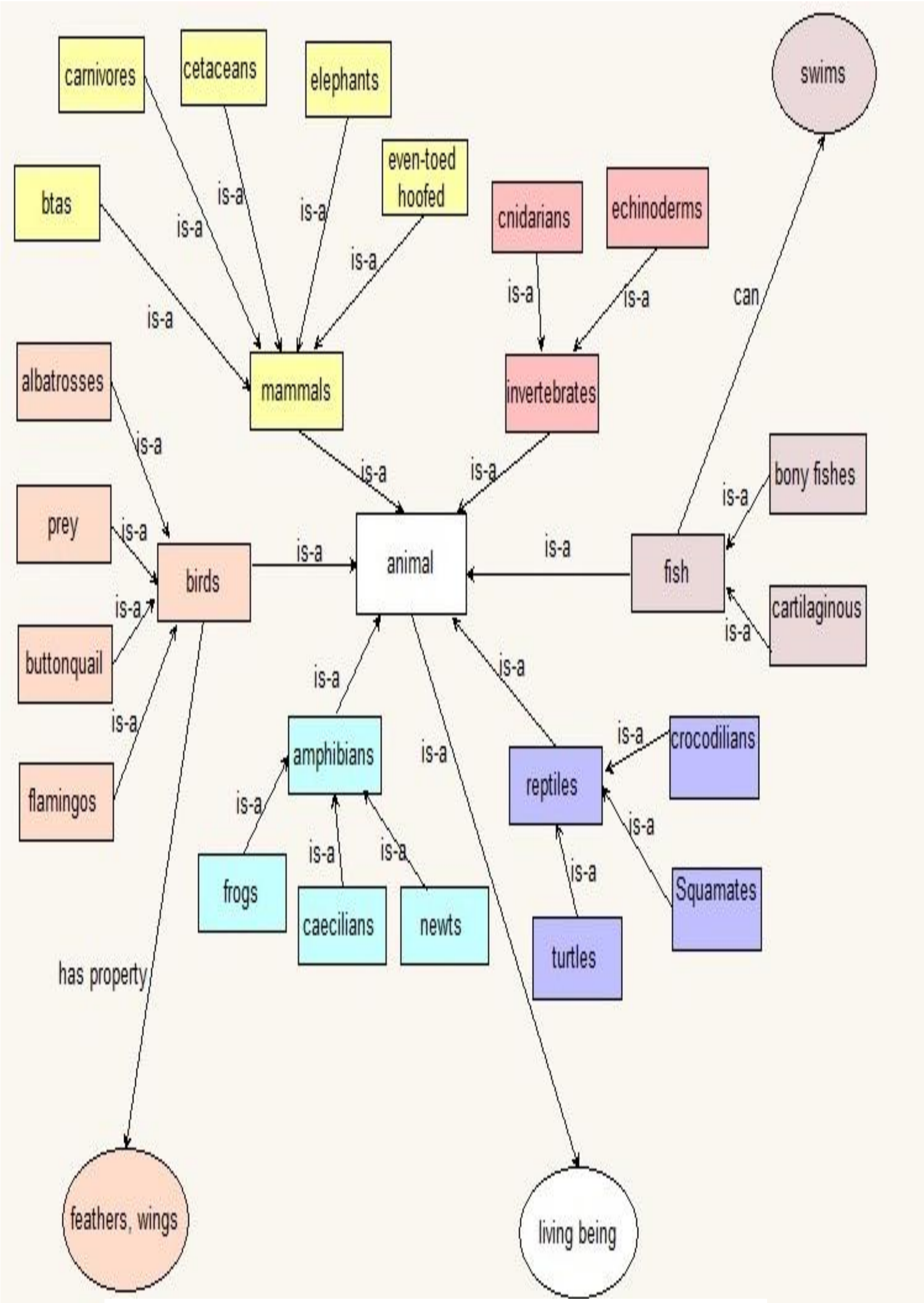


Figure 26: Semantic network with six main groups of objects

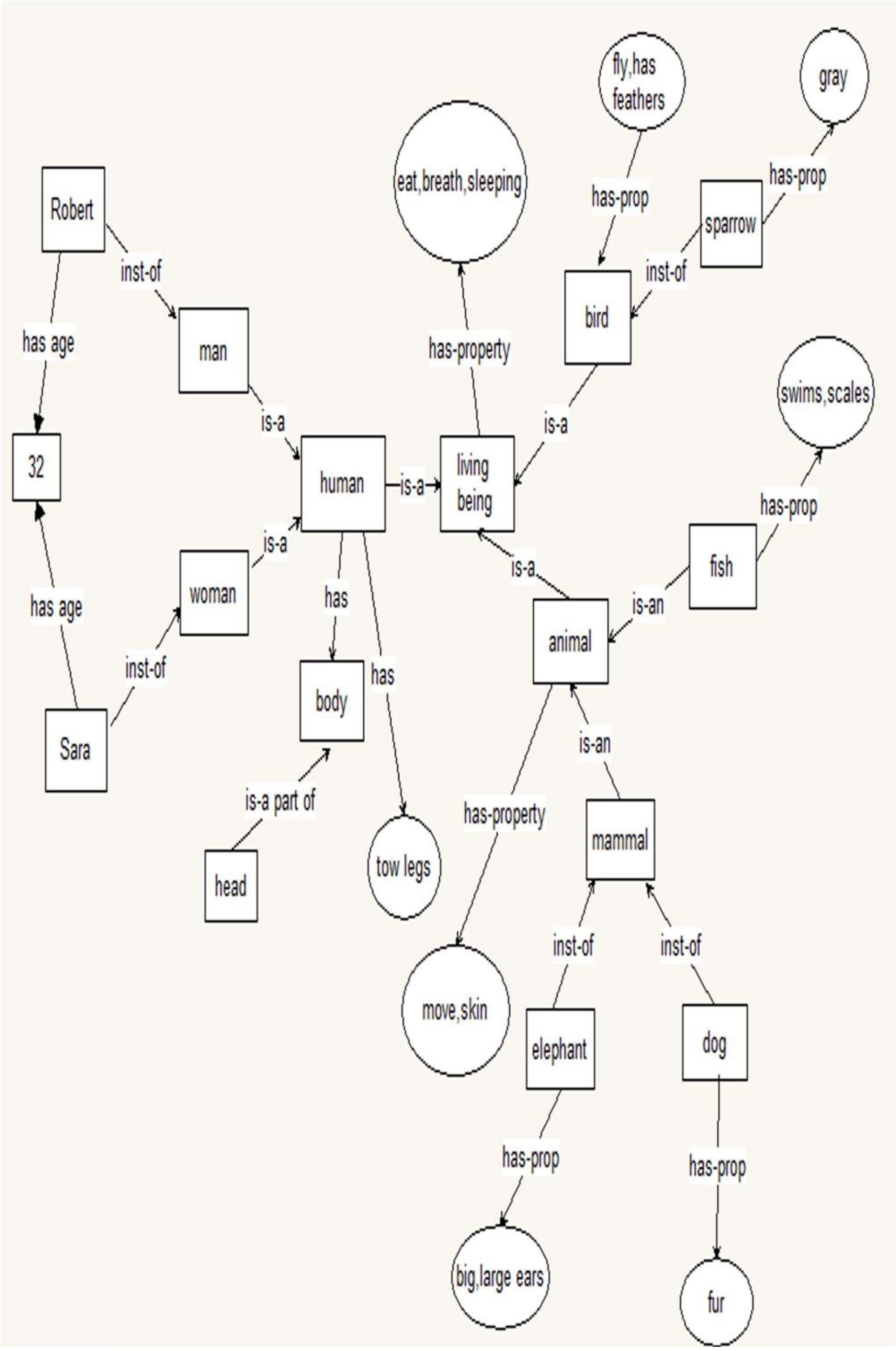


Figure 27: Example of combining different semantic network structures

Chapter 4

FRAME KNOWLEDGE REPRESENTATION FORMALISM

4.1 Basics of frame-based knowledge

Frame-based representation is an important knowledge representation formalism permitting us to show the concept of inheritance. The frame technique includes a number of frames or nodes that are related to each other by relationships. Every frame explains both an instance and a class frame. The idea of frame firstly was presented by Marvin Minsky in 1975 as the major way to show a range of knowledge.

A frame is a group of properties identifying the condition of an object, and this object is related with other frames or objects. Actually a frame is more than only a record or perhaps a data structure that contains data. In artificial intelligence the frame is known as a slot-filler knowledge representation method.

To date, we explained that instance tends to be an “object”. In this case, an object could be a physical object, however it doesn’t become. An object may be a property (like a shape or a color), or a location or a scenario or an emotion. This concept of an object is like the same as previously used in object oriented programming languages like Java or C. The frames can be used to create an expert system, because it is a representation of an object oriented programming.

4.2 History of a frame

In 1975, a knowledge representation structure that was definitely different via formalisms that were applied in those days, and called logic-based and rule-based formalisms. Minsky suggested that arranging knowledge directly into chunks is known as frames. These types of frames are designed to capture the actual essence associated with concepts as well as stereotypical conditions.

Particulars that had been omitted throughout Minsky's report were afterwards stuffed through knowledge representation techniques that were motivated by Minsky's concepts, two of the most noticeable being are FRL *(*Frame Representation Language*),* and KRL (knowledge representation language) (Daniel G. Bobrow and Terry Winograd, 1977). KRL was essentially the most committed project dealing with every representational dilemma mentioned in the literature. The outcome of a net is a really difficult language having a quite rich repertoire associated with representational primitives in addition to nearly unrestricted flexibility.

The popular attributes in FRL and KRL as well as afterwards used frame-based techniques (Fikes and Kehler in 1985) are:

1) The structure of frames is like consisting of frames arranged in a hierarchical form;

2) In frames the main constituents are slots, and the fillers used for these slots must be specified;

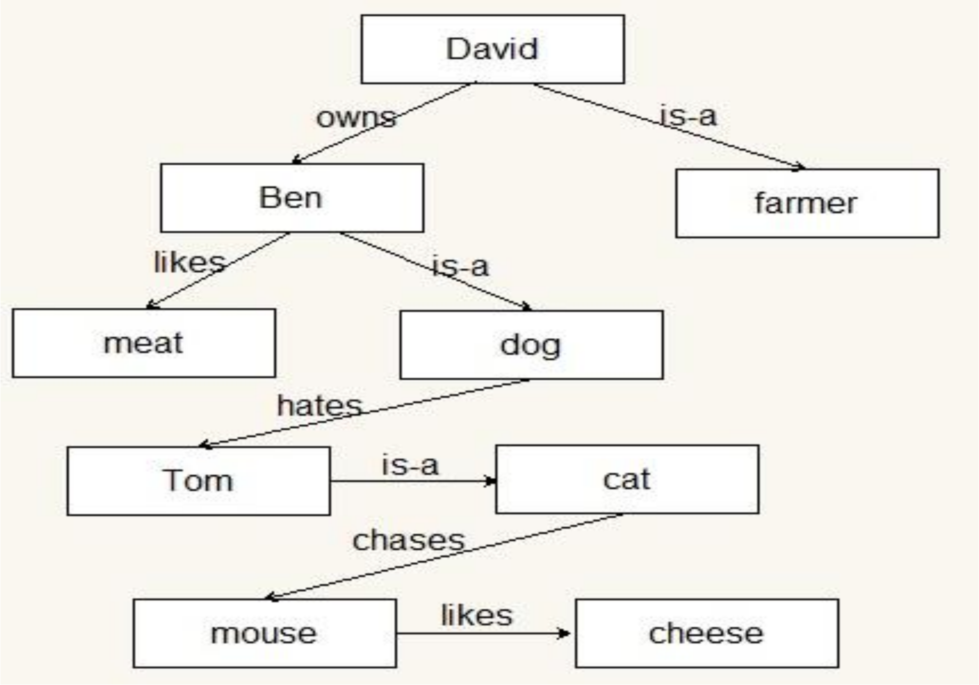
3) Characteristics (fillers, limitation upon filler etc.) are generally inherited by superframes to be able to use “subframes” from the structure according to several inheritance techniques. These types of organizational concepts developed very helpful and common object oriented languages.

4.3 Structure of a frame-based system

Every frame provides a number of slots which are designated as slot values. This is the way the frame network is created. Instead of simply processing links among frames, every relationship is indicated by away from a value being put into any slot. For instance, the semantic network is represented in the form of frame in figure 28.

The frame system can be shown in another form called diagrammatic, and it is represented in figure 29.

Whenever we point out that “Ben is a dog“, we actually mean that “Ben is an instance with the class of dog“ or “Ben can be a member of the class of dogs“. The “is a“ connection is important in a frame-based system since it permits to state a membership associated with classes. This connection can be referred as a generalization due to the fact refereeing to the actual class associated with mammals, and is more common in comparison with the class “dog”, and the class “dog” is more common than the class “Ben”.



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

Figure 28: Representation of semantic network in the form of frame

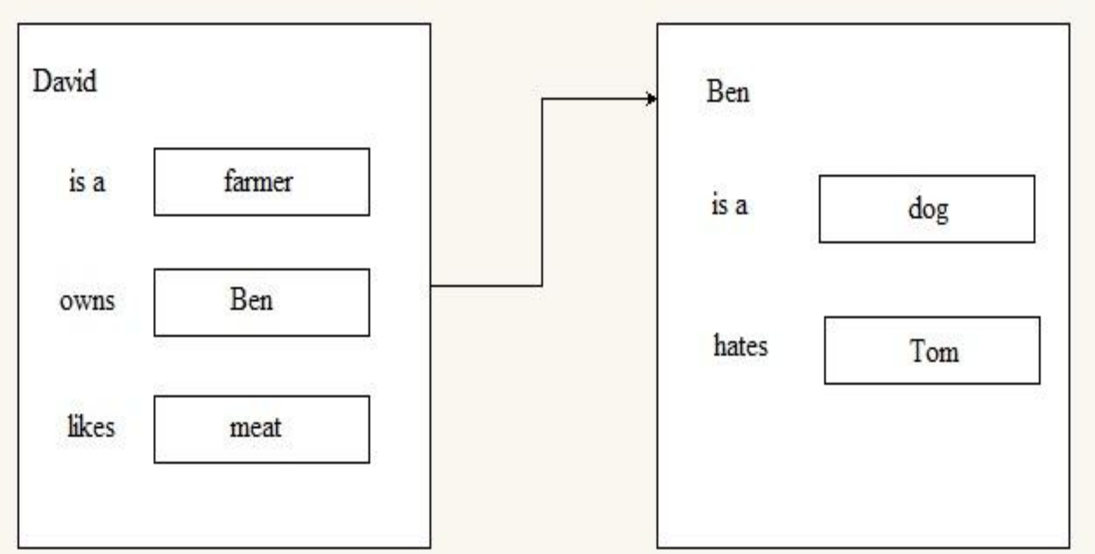


Figure 29: Diagrammatic form of frame-based system

Additionally, it is practical to be able to discuss one object currently being a component of another object. For instance, Ben has a tail, and the tail is one of the parts of Ben. This connection is referred as aggregation in order Ben can be viewed as an aggregate of parts of dog.

Some other relations are generally called association. An instance of such a connection is the “hates” relationship shown in figure 28. This clearly shows that how Ben and Tom are related with each other. This relationship (association) has two direction meanings. The point that Ben hates Tom shows that Tom is hated by Ben, therefore we’re truly indicating two relationships in a single association.

The frame is just like a record construction and related to the fields and values which are generally slots as well as slot fillers. Generally speaking, the frame is a set of fillers and slots which are identified as stereotypical objects. An individual frame isn't much beneficial. The frame technique has a set of frames that can be joined together. The attribute value of one of the frames may become another frame.

The frame example of the book "Artificial Intelligence" is represented in figure 30.

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

Figure 30: Frame example of the book "Artificial Intelligence"

The figure 31 shows a frame example of personal data.

4.3.1 The term class and instances

A frame may be sometimes referred to a specific object or a group of comparable objects. To be more specific, we use the actual instance frame while dealing with a specific object as well as the class-frame while talking about a similar object. For example, in figure 32 the frame example of computer "Dell Inspiron5110" is represented.

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

Figure 31: Frame example of personal data

Class	Computer
Code :	62720
Model :	Dell
Processor :	Core i3 M370
Hard disk :	500GB
Memory :	4GB
CD-ROM :	DVD-RW
Screen :	15.6
Mouse :	Pad
Keyboard :	Yes
Battery :	6Cell
Camera :	1.3 MP
Wireless :	DW1501
Bluetooth:	Yes

Figure 32: Frame example of computer “Dell Inspiron5110”

A class-frame explains a set of objects with typical features. The person, car, and computer are class-frames.

4.3.2 Slot object as full-fledged

It was noticed that the frame-based representation may be built much more effectively by enabling the slot filler to get much easy ideas. This consists of being frames in their own title with a full field of hierarchical plans. The basic filler attributes are characterized as follows:

1) Contents regarding whether or not the slot is single or multi-valued;

2) Limitation about the ranges associated with values as well as kind of values;

3) Easy default values of the property;

4) Principles with regard to inheriting values of the property;

5) Principles with regard to processing values individually by inheritance;

6) The classes/frames to which they may be connected.

7) Inverse of properties.

4.3.3 Slots in a frame

The frame can be described by a set of slots. Every slot explains a specific feature or procedure from the frame. Slots are used to keep values. A slot may possibly include default values of different frames, and a collection of principles by which the actual slot values can be obtained.

4.3.4 Common knowledge in a slot

The following common knowledge is included in the slot of frame:

1) The name of the frame;

2) A connection of one frame to other frames. For example, the frame of computer “Dell Inspiron5110” in figure 32 can be a member of computer class which is related to the hardware class;

3) The value of slots: a value of slots may be Boolean, numeric or symbolic. The slot value is usually allocated at the time of creating a frame or within a procedure while using the expert systems;

4) Defaulting of slot values: this is actually correct while no evidence on the opposite has been identified;

5) The range of slot values: The field of the slot value fixes whether the specific object is complied with the stereotype necessities outlined by the frame. For instance, the price of a car can range between $5000 and $40000;

6) The procedural knowledge: A slot has a procedure connected to it, and this is carried out when the slot value is required or modified;

7) Frame-based system provides an expansion for the slot value construction by using facets. The facet is really a way of supplying an extended knowledge that deals with a frame attribute. Facets can be used to establish the value of attribute, to manage the end-user requests etc.

4.4 Advantages and disadvantages of frame knowledge representation formalisms

There are some advantages of a frame-based knowledge representation method described below:

1) The frame knowledge representation makes the programming simpler by grouping related data;

2) Compare to the knowledge representation method described in the form of production rules, the frame is flexible and intuitive in many application areas;

3) The frame representation is easily understood and used by people who are neither programmer nor designer of a system;

4) It is not hard to add slots for new attributes and relations;

5) It is simple to include default data and to discover the missing values.

The frame knowledge representation formalism has some disadvantages described below:

1) It is difficult to use the frame system in a program, so the algorithm is required in the process of using the frame in the program;

2) The lack of low-priced computer software;

3) Inference mechanism is not easily processed in a frame system.

Chapter 5

CONCLUSION

A large amount of knowledge is available in our daily life. The larger the quantity of knowledge, the more demands are there for tools and techniques sharing the knowledge.

The knowledge representation is one of the most important concepts in Artificial Intelligence. The successful representation of knowledge increases the efficiency of the intelligent system.

There are different knowledge representation formalisms, and this thesis studies two of them - the semantic network and frame. The important roles of semantic network and frame formalisms consist in their effective use for description the relations among concepts.

The basic properties of semantic network and frame methods for structuration and organization the knowledge are presented in this thesis. The conceptual graph based on semantic network is considered. The different types of semantic network are described. The structure of frame-based system is analyzed. The advantages and disadvantages of both semantic network and frame formalisms are discussed.

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