4 Knowledge Representation and Related Issues

Syllabus

Representations And Mappings, Approaches To Knowledge Representation, Representation.

Contents

4.1 Representation and Mappings

GTU : Winter-14,18,19, Summer-16,18,20

4.1.1 Introduction

- Search-based problem solving programs require some knowledge to be implemented. Knowledge can be a particular states or path toward solution, rules, etc. Before being used this knowledge must be represented in a particular way with a certain format. Knowledge Representation (KR) is an important issue in computer science in general and in AI in particular. "The dominant paradigm for building intelligent systems since the early 1970s has been based on the premise that intelligence presupposes knowledge". Generally, knowledge is represented in the system's knowledge base, which consists of data structures and programs. In addition, the intelligent system is expected to have a program called an inference engine that implements the reasoning patterns necessary for the task at hand. Thus current AI theory and practice dictate that intelligent systems be knowledge based, consistent with this simple knowledge base plus inference engine architecture. This emphasis on knowledge has led to suggestions that AI can be arguably called applied epistemology".

4.1.2 Issues in Knowledge Representation

- Are any attributes of objects so basic that they occur in almost every problem domain ? If there are such attributes then we need to make sure that they are handled appropriately in each of the mechanism we propose. If such attributes exists, what are they ? There are several issues that must be considered when representing various kinds of real-world knowledge.

Important Attributes

- Are there any attributes that occur in many different types of problem ?

- There are two *instance* and *isa* and each is important because each supports property inheritance.
- There are two important attributes that are of general significance such as ISA and instances. These attributes are important because they support property inheritance. Relationship among attributes must be considered carefully which is depicting more knowledge.

❑ Relationships

- What about the relationship between the attributes of an object, such as, inverses, existence, techniques for reasoning about values and single valued attributes. We can consider an example of an inverse in

band(John Zorn,Naked City)

This can be treated as John Zorn plays in the band Naked City or John Zorn's band is Naked City.

Another representation is band = Naked City

- band-members = John Zorn, Bill Frissell, Fred Frith, Joey Barron,

❑ Granularity

- At what level should the knowledge be represented and what are the primitives. Choosing the Granularity of Representation Primitives are fundamental concepts such as holding, seeing, playing and as English is a very rich language with over half a million words it is clear we will find difficulty in deciding upon which words to choose as our primitives in a series of situations.

If Tom feeds a dog then it could become :

feeds(tom, dog)

If Tom gives the dog a bone like :

gives(tom, dog,bone) Are these the same ?

In any sense does giving an object food constitute feeding ?

If give(x, food) → feed(x) then we are making progress.

But we need to add certain inferential rules.

In the famous program on relationships Louise is Bill's cousin How do we represent this ? louise = daughter (brother or sister (father or mother(bill))) Suppose it is Chris then we do not know if it is Chris as a male or female and then son applies as well.

Clearly the separate levels of understanding require different levels of primitives and these need many rules to link together apparently similar primitives.

- Obviously there is a potential storage problem and the underlying question must be what level of comprehension is needed.

- The finest level of knowledge that is granularity is another issue to handle. Granularity is level of knowledge that needs to be represented. For this, one should have complete primitive (basic) understanding of the knowledge to be represented in the system.
- Other significant issues those need to be handled are Inverses, Existence in an Isa hierarchy, Technique for reasoning about values, Single-valued attributes. Major attributes are required to be identified. The set of objects whose knowledge is required to be stored should be clearly identified.

4.1.3 The Techniques of Representation and Mappings

AI can be used to solve a complex problems encountered within. Nevertheless large amount of knowledge as well as some means of manipulating that knowledge is required so as to create solutions for new problems. In the representation there are two different entities that must be considered :

- Facts : truths in some relevant world. These are things that we want to represent.
- Representation of facts in some chosen formalism. These are things that can actually be manipulated.

Structuring of these entities can be done in two levels :

- The *knowledge level* at which facts are described.
- The *symbol level* at which representation of some objects at the knowledge-level are defined in terms of symbols that can be manipulated by programs.

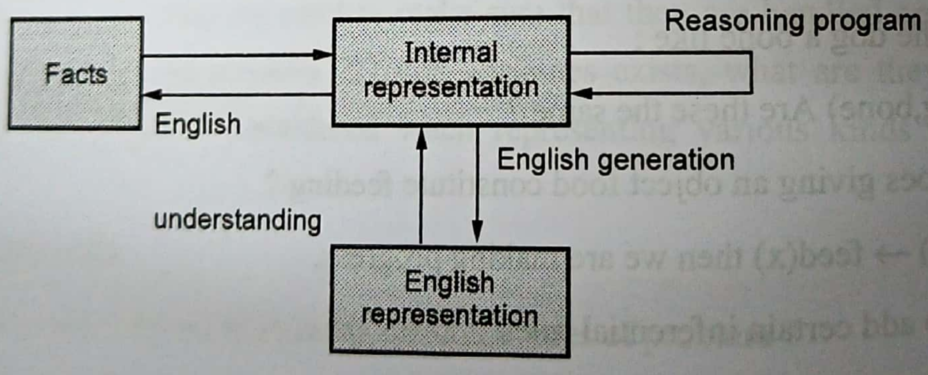

Fig. 4.1.1 Mappings between facts and representation

Our main goal is to focus on facts, representation as well as the two-way mappings that must exist between the two as shown in the Fig. 4.1.1 above. The links in the figure are called *representation mappings*. In representation mappings, there are :

- Forward *representation* which maps from facts to representation.

- Backward *representation* which maps the other way.

One representation of facts concerns with natural language (particularly English) sentences is that, regardless of the representation for facts that we use in a program, we may also need to be concerned with an English representation of those facts that in order to facilitate getting information into and out of the system. We must also have mapping functions from English sentences to the representation which we are actually going to use and from it back to sentences as shown in the Fig. 4.1.1. For example we can use mathematical logic as the representation formalism. Consider the English sentences below.

Tommy is a dog. This fact can also be represented in logic as follows : *Dog(Tommy)*

Suppose also we have a logical representation of the fact : *all dogs have tails* as explained below. Using the deductive mechanisms of the logic, we may generate the new representation object. Using an appropriate backward mapping function we could then generate the English sentence : *Tommy has a tail* Or we can make use of this representation of new fact to cause us to take some appropriate action or to derive representation of additional facts.

Consider example of the Multilated Checkerboard Problem. "Consider a normal checker board from which two squares, in opposite corners, have been removed. The task is to cover all the remaining squares exactly with donimoes, each of which covers two squares. No overlapping, either of dominoes on top of each other or of dominoes over the boundary of the multilated board are allowed. Can this task be done ?".

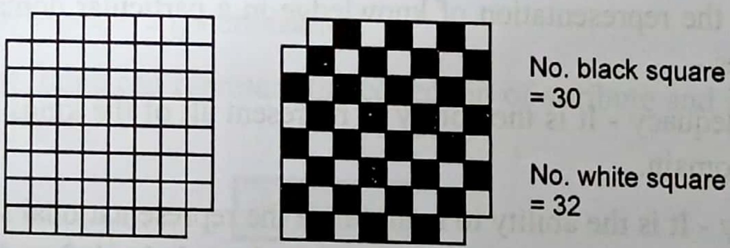

Fig. 4.1.2 A multilated checker board

A example follows :

- Checkerboard total contains 32 white squares and 30 black squares.
- When every domino cover two neighboring squares, a black one and a white one, then first thirty dominos cover 30 black squares and 30 white squares, and leaving two white square and zero black domino.
- These two black squares can not be adjusted and can not cover remaining domino.
- It is impossible to cover all 62 squares with 31 one dominos.

An observation which can be made in the computation is that the number of black squares correspond to the number of dominoes in the partial covering. The same is true for the number of white fields, which enforces the number of black squares to coincide with the white squares, when investigated the inter play between covered squares on the board and dominoes contained in the partial covering.

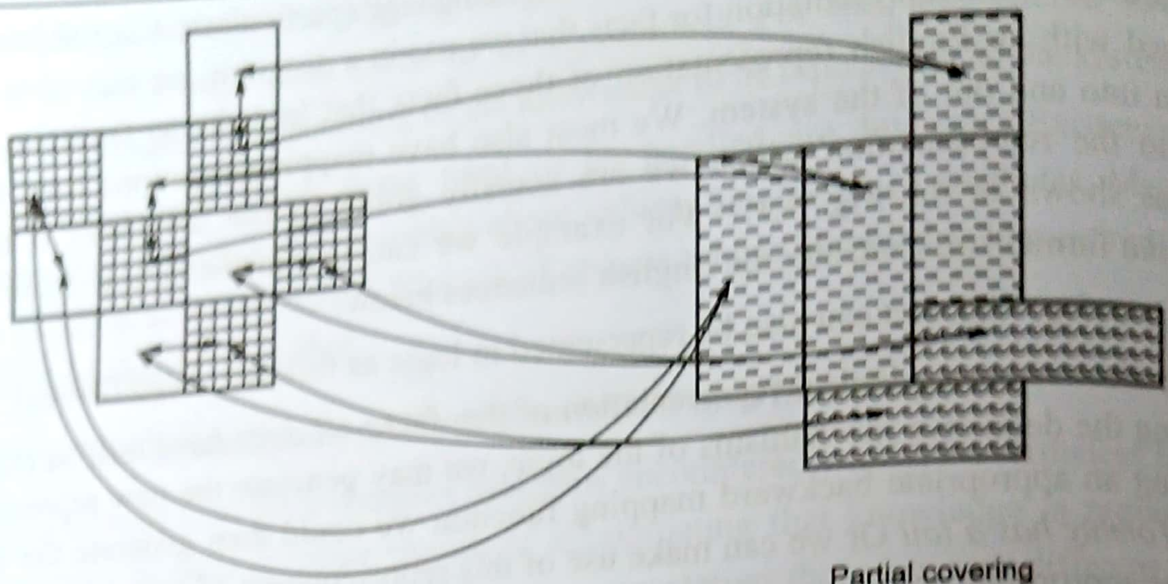

Fig. 4.1.3 Observation

4.2 Approaches to Knowledge Representation

GTU : Summer - 15, 17, 18, 20, Winter - 18

A good system for the representation of knowledge in a particular domain should possess the following properties -

- Representational adequacy - It is the ability to represent all of the kinds of knowledge that are needed in that domain.
- Inferential adequacy - It is the ability to manipulate the representational structures in such a way as to derive new structures corresponding to new knowledge inferred from old.
- Inferrential efficiency - It is the ability to incorporate into the knowledge structure additional information, that can be used to focus the attention of the inference mechanisms in the most promising direction.
- Acquisitional efficiency - Acquiring new information easily.

Two types of approaches to knowledge representation :

1) Simple relational knowledge
2) Inheritable knowledge

1) Simple relational knowledge

- This is the simplest way of storing fact which uses relational method, when every and each fact about a set of objects is set out sequentially and automatically in column.
- This type of representation is small procedure for inference.
- It is used to define inference engines.

For example

Player	Weight	Age	Play cricket
Monu	70	30	Right H.
Sonu	65	25	Right H.
Bablee	50	29	Left H.
Soni	45	29	Right H.
Moni	42	25	Left H.

Player_info ('Monu', 70, 30, right H)

2) Inheritable knowledge

- Relational knowledge is made up of object associativity like co-relation associated values attribute.
- All data should be organised into a hierarchy of classes.
- Inherit values from being all members of class.
- Class must be arranged in a generalization.
- Every individual frame can represent the collection of attribute and its value associated with a individual node.

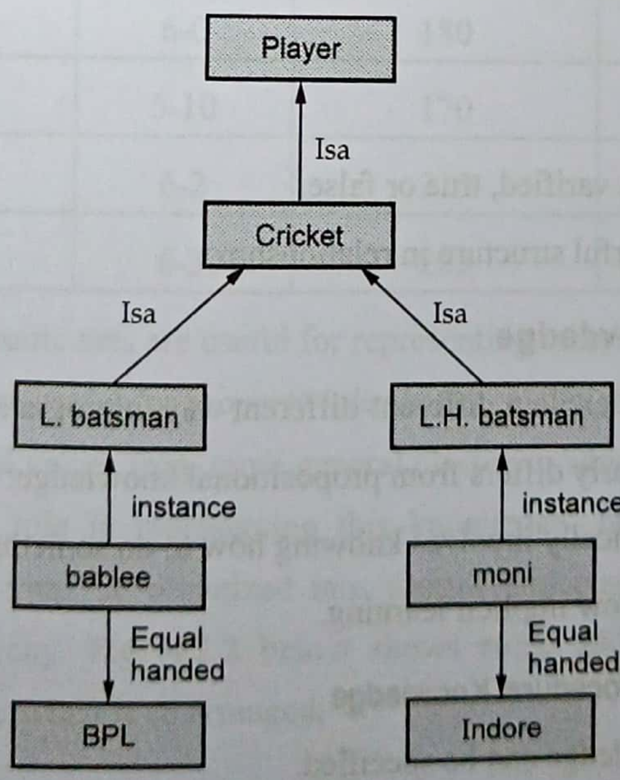

Fig. 4.2.1 Inheritable knowledge

❑ Example

Properties of inheritance hierarchy

1)  to be point from object and its value.

2) Boxed : to be object and value of attribute any object.

3) It may be also be called slot-and filter structure.

Algorithm retrieve

To retrieve a value for attribute of an instance object.

1) Find object in the knowledge base.

2) If there is a value for the attribute, report that value.

3) Otherwise look value of instance, if not then fail, otherwise go to the node and value for the attribute, if one is found, report it. Otherwise, do until there is n search using ISA, found for the attribute.

4.2.1 Inferential Knowledge

When inheritance property is very useful form of inference, represent the knowled formal logic.

All cat have tails $\forall x : \text{dog}(x) \rightarrow \text{has a tail}(n)$

❑ Set of rules

1) Define require fact.

2) Additional statement is varified, true or false.

3) Logic provides a powerful structure in relationships.

4.2.2 Procedural Knowledge

- Procedural knowledge can explain different-different way in program.
- Procedural knowledge clearly differs from propositional knowledge.
- Procedural knowledge basically involves knowing how to do something.
- Procedural knowledge follow implicit learning.

4.2.2.1 Advantages of Procedural Knowledge

1) Property specific knowledge can be specified.

2) Extended logical inference is possible.

4.2.2.2 Disadvantages of Procedural Knowledge

1) Consistency : all deduction are not always correct.

2) Completeness : all cases are not easy to represent.

There are multiple techniques for knowledge representation. Different representation formalisms are,

- Rules
- Logic
- Natural language
- Database systems
- Semantic nets
- Frames

Many programs rely on more than one technique

- Database system - They are used in representing Simple Relation Knowledge which is in declarative facts and can be said as a set of relations of the same sort within database systems. Fig. 4.2.2 shows an example of such systems.

Player	Height	Weight	Bats-Thrown
Ram	6-0	180	Right-Right
Shyam	5-10	170	Right-Right
Veer	6-2	215	Left-Left
Tarun	6-3	205	Left-Right

- Semantic nets - Semantic nets are useful for representing inheritable knowledge. Inheritable knowledge is the most useful for *property inheritance*, in which elements of specific classes inherits attributes and values from more general classes in which they are included. Frames also do play a big role in representing this knowledge. In order to support property inheritance, objects must be organized into classes and classes must be arranged in a generalization hierarchy. Fig. 4.2.2 below shows some additional baseball knowledge inserted into a structure that is so arranged.

❑ Example :

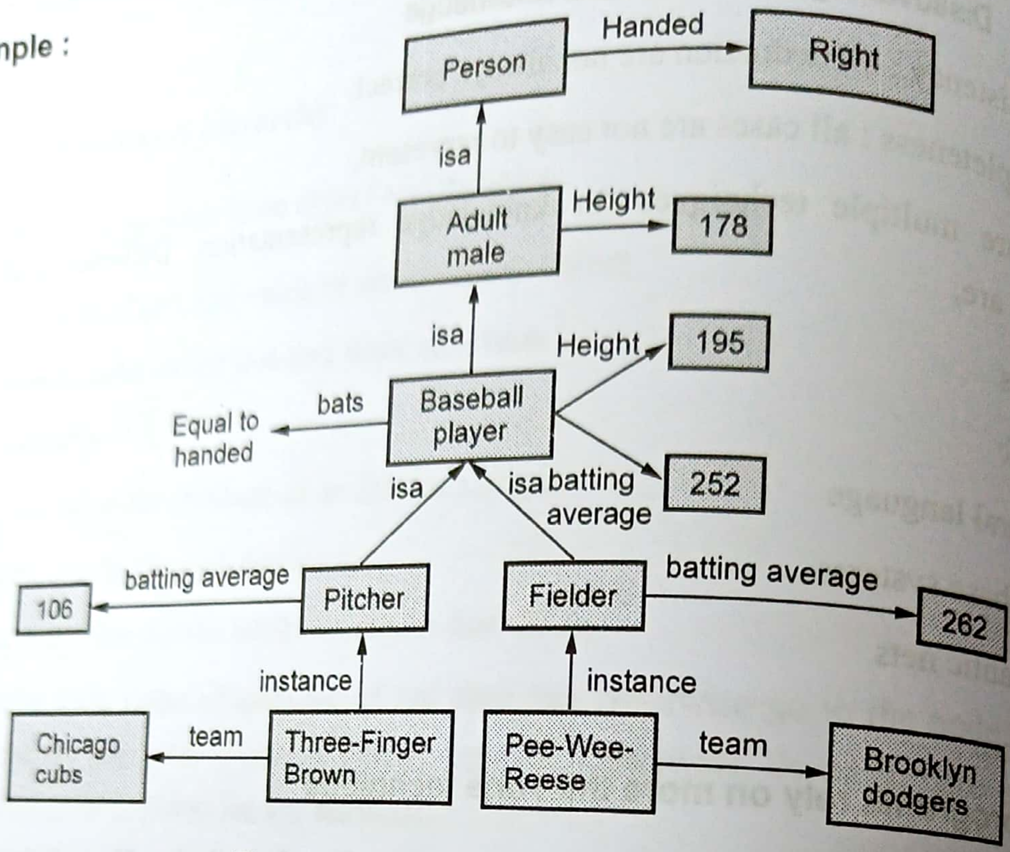

Fig. 4.2.2 Inheritance hierarchy

Isa hierarchy is normally used in semantic nets/frames. Lines represent attributes. Bo nodes represent objects and values of attributes of objects. Correct deduction from Fig. 4 could be : height of Three-Finger Brown is 195 cm. An incorrect deduction could be : hei of Three-Finger Brown is 178 cm. The structure shown in the Fig. 4.2.2 is a *slot-and-fi* structure. It may be also called a *semantic network* or a collection of frames.

❑ **Predicate logic**

- Predicate logic is used to represent inferential knowledge.
- Logic provides powerful structure in which to describe relationships among values.
- It can be combined with some other powerful description language with an ISA hierarchy

❑ **Production rules**

- Production rules are useful in representing procedural knowledge.
- Procedural knowledge is form of operational knowledge which specifies what to do when
- Previously it was done using programming language such as LISP.
- However it was hard to reasoning with this method hence in AI programs procedur knowledge is represented using production rules.

❑ Inheritable knowledge

Relational knowledge is made up of objects consisting of

- Attributes
- Corresponding associated values.

We extend the base more by allowing inference mechanisms :

- Property inheritance
  - Elements inherit values from being members of a class.
  - Data must be organised into a hierarchy of classes (Fig. 4.2.3).
- Boxed nodes -- objects and values of attributes of objects.
- Values can be objects with attributes and so on.
- Arrows -- point from object to its value.
- This structure is known as a slot and filler structure, semantic network or a collection of frames.

The algorithm to retrieve a value for an attribute of an instance object :

1. Find the object in the knowledge base.
2. If there is a value for the attribute report it.

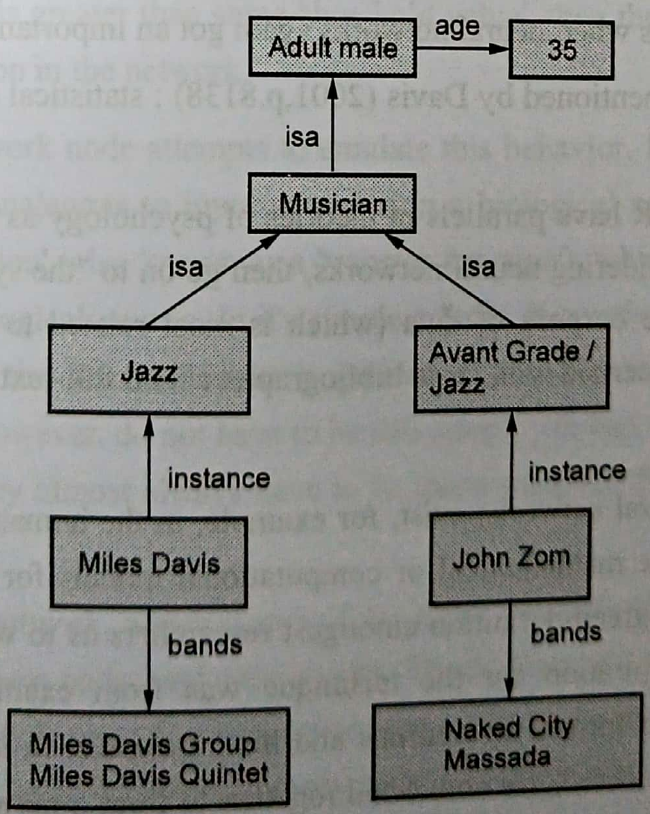

Fig. 4.2.3 Property inheritance hierarchy

3. Otherwise look for a value of instance if none fail.
4. Otherwise go to that node and find a value for the attribute and then report it.
5. Otherwise search through using isa until a value is found for the attribute.

- Knowledge Representation (KR) is an important issue in computer science in general and in AI in particular. "The dominant paradigm for building intelligent systems since the early 1970s has been based on the premise that intelligence presupposes knowledge. Generally, knowledge is represented in the system's knowledge base, which consists of data structures and programs. In addition, the intelligent system is expected to have a program called an inference engine that implements the reasoning patterns necessary for the task at hand. Thus current AI theory and practice dictate that intelligent systems be knowledge based, consistent with this simple knowledge base plus inference engine architecture. This emphasis on knowledge has led to suggestions that AI can be arguably called applied epistemology".
- The approach described above may be termed the symbol-manipulation approach. Historically, however, AI grew out of work in which another approach, neural networks (or connectionism or parallel distributed processing or non-symbolic representations) played the major role, but this approach was outplayed by the symbol-manipulation approach until the 80s when neural networks again got an important role.
- A final approach is mentioned by Davis (2001,p.8138) : statistical analysis of large corpora of data.
- The approaches to KR have parallels in theories of psychology as well as in epistemology. We will start by considering neural networks, then go on to "the symbolic" approaches and finally consider large corpora of data (which is most related to library and information science, which is concerned with large bibliographical and full-text databases).

❑ Neural networks

- While biological neural networks exist, for example, in the human brain, Artificial Neural Networks (ANN), are mathematical or computational models for information processing. There is no precise agreed definition amongest researchers as to what a neural network is, but the original inspiration for the technique was from examination of bioelectrical networks in the brain formed by neurons and their synapses. In a neural network model, simple nodes (or "neurons") are connected together to form a network of nodes, hence the term "neural network".

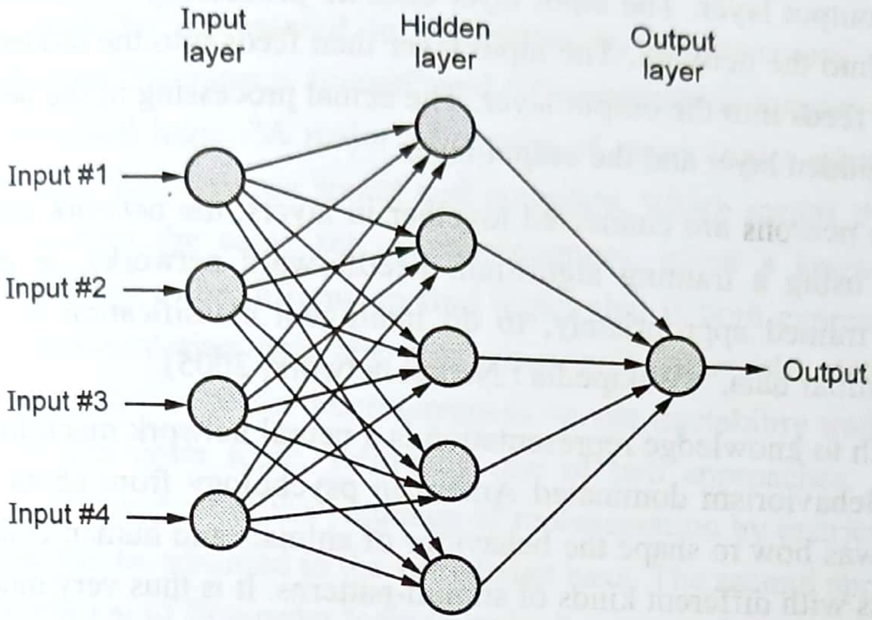

Fig. 4.2.4 A model of a neural net

- In a typical neural network, each node operates on a principle similar to a biological neuron. In a biological neuron, each incoming synapse of a neuron has a weight associated with it. When the weight of each synapse, times it's input, is summed up for all incoming synapses and that sum is greater than some 'threshold value', then the neuron fires, sending a value to another neuron in the network.
- The typical neural network node attempts to emulate this behavior. Each node has a set of input lines which are analagous to input synapses in a biological neuron. Each node also has an 'activation function' (also known as a 'transfer function'), which tells the node when to fire, similar to a biological neuron. In it's simplest form, this activation function can just be to generate a '1' if the summed input is greater than some value or a '0' otherwise. Activation functions, however, do not have to be this simple - in fact to create networks that can do useful work, they almost always have to be more complex, for at least some of the nodes in the network.
- A feedforward neural network, which is one of the more common neural network types, is composed of a set of these nodes and connections. These nodes are arranged in layers. The connections are typically formed by connecting each of the nodes in a given layer to all of the neurons in the next layer. In this way every node in a given layer is connected to every other node in the next layer.

- Typically there are at least three layers to a feedforward network : an input layer, a hidden layer and an output layer. The input layer does no processing : it is simply where the data vector is fed into the network. The input layer then feeds into the hidden layer. The hidden layer, in turn, feeds into the output layer. The actual processing in the network occurs in the nodes of the hidden layer and the output layer.
- When enough neurons are connected together in layers, the network can be 'trained' to do useful things using a training algorithm. Feedforward networks, in particular, are very useful, when trained appropriately, to do intelligent classification or identification type tasks on unfamiliar data." (Wikipedia : Neural network, 2005).
- As an approach to knowledge representation is a neural network much like behaviourism in psychology. Behaviorism dominated American psychology from about 1913 to 1970. Its main interest was how to shape the behaviour of animals and human beings by confronting such organisms with different kinds of stimuli-patterns. It is thus very much an input-output approach (or stimuli-response approach). They tried to avoid mental terms (e.g. memory) and to replace them with terms referring to relations between stimuli and responses (e.g. replace "memory" with "delayed response"). Although most behaviourists neglected brain structures and processes and preferred to look at the brain as a "black box", some behaviourists were interested in brain models, and the idea of neural networks was put forward for the first time by the behaviourist Donald O. Hebb in 1949.
- Both the computer technology of neural nets and behaviourism are closely connected to epistemological ideas developed in particular by classical British empiricism. The basic idea may be that knowledge is represented in the brain as a result of stimuli-processes, where learning based on repetitions of similar stimuli follows the laws of association. From our point of view the most important issue is that knowledge representation is provided by somebody who is in control of the learning process. It is his or her view of what represents wanted behaviour that indirectly manage what is considered true, relevant and important knowledge. This knowledge is not formulated and provided directly, but is implemented in the system or the organism by manipulating the stimulation of the system or organism (simplified : by feedback which involves rewards and/or punishment).

❑ Symbol representation

- There are several approaches to knowledge representation in AI, which can be seen as subcategories of the symbol-representation approach. They all share the conditions that knowledge is explicated by the use of some kind of symbolic language and is installed in the system "manually", piece by piece. The four most important kinds of symbolic systems may be a) logic based systems b) semantic networks and c) frame-based systems.

a) Logic based representations

- Knowledge may be represented in computers by programmers writing declarative sentences such as "Socrates is human" and "if somebody is human, then she is mortal" using mathematical logic. "A major advantage of many logics adopted for knowledge representation is that they are sound and complete, which means that derivability and provability lead to the same set of consequences, given a knowledge base. It has however turned out to be difficult to find logics that is both expressively adequate for knowledge representation and also computationally tractable. "Attempts to find an acceptable compromise to the expressiveness versus tractability trade-off generally use variations of first-order logic, following one of two approaches. The first approach limits the expressiveness of the language of representation by restricting the form of the formulas that can be admitted in the knowledge base. The second approach redefines the provability relation of first-order logic to make it computational tractable.
- Relational databases . . . widely used to represent "simple" facts, such as people's addresses or salaries, constitute a good example of the first approach (. . .)." (Kramer and Mylopoulos, 1992, p. 745-746). The second approach may for example make a slight change in the semantics of existential quantification which makes large representations computational tractable, but this has a remarkable impact on the provability relation.
- Logic based systems may also use **procedural representations**. "Declarative representations treat the intended meaning of a knowledge base as a foundation that imposes constraints on knowledge base operations. Procedural representations, on the other hand, reverses this dependency by identifying the meaning of a knowledge base with its use"(Kramer and Mylopoulos, 1992, p. 746).

b) Semantic networks

- Semantic networks are knowledge representation schemes involving nodes and links between nodes. The nodes represent objects or concepts and the links represent relations between nodes. The links are directed and labeled. Semantic nets were originally motivated by cognitive models of human memory.
- According to Kramer and Mylopoulos (1992, p. 747-748) their popularity and success can best be understood as a convenient compromise between the declarative and the procedural extremes, while "others have argued that semantic networks offer a fundamentally different representational paradigm that is object centered in the sense that it is based on object descriptions rather than arbitrary propositions and focuses on knowledge organization.

- WordNet is an example of a semantic net. The semantic web is a concept that re... a major research program with semantic networks. For many persons this i... semantic web represents the kind of knowledge organization with the most pr... prospects.

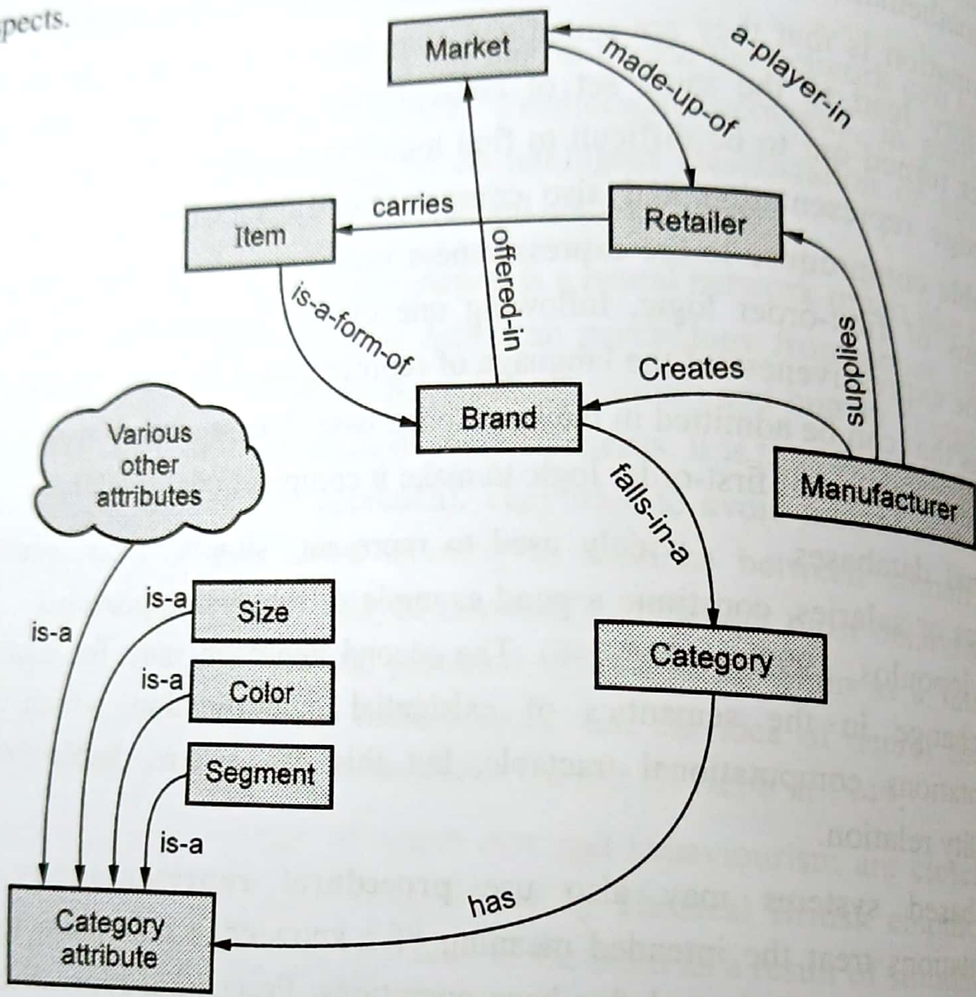

Fig. 4.2.5 Semantic nets

c) Frame-based representations

- Frame-based systems are knowledge representation systems that use frames, a... originally introduced by Minsky (1975), as their primary means to represent... knowledge. A frame is a structure for representing a concept or situation s... "restaurant" or "being in a restaurant". Attached to a frame are several k... information, for instance, definitional and descriptive information and how to... frame. Frames are supposed to capture the essence of concepts or stere... situations, for example going out for dinner, by clustering all relevant inform... these situations together. This means, in particular, that a great deal of proc... expressed knowledge should be part of the frames. Collections of such frames ar... organized in frame systems in which the frames are interconnected.

- Obviously, frame-based systems are in many ways similar to object-oriented programming languages; indeed, the two theories interacted strongly in their development.
- The chief advantages of frame-based architectures are expressivity, flexibility and ease of use. The chief disadvantages is lack of precision and lack of a well defined model of inference. The architecture provides a wealth of features and options for both representation and inference, but only a weak underlying model. Hence, in a complex case, it is difficult to predict how these features will interact or to explain unexpected interactions, which makes debugging and updating difficult.
- From a psychological point of view has a tendency to overuse frames as explanations been critized : "I am not going to argue against the `existence' (whatever that may be) of organised knowledge structures. What I will do is place doubts on the explanatory value of concepts as frames, conventions, scripts and so on. . . Even if there are structures like frames and scripts, they are relatively easy for people to override. People can still use arbitrary knowledge of the world to understand sentences and scenes : you cannot exclude any part of the knowledge base in advance, using some general prestructuring of that knowledge. Therefore, the content of such structures as frames and scripts must themselves be both analyzable and subject to reasoning by their users, which puts us back almost where we started. What we have gained is a summary of the aggregate regularities frequently or typically, exhibited. The structures themselves tell us nothing about people's cognitive capacities, only about what are probably quite ephemeral habits of thought which people can change. In terms of Billig (1987) frames and scrips lack any kind of `witcraft'. Frames, scripts and related concepts summarize some of the patterns that emerge when people don't bother to think. " (Vliet, 1992)

❑ General epistemic aspects of KR in computer science

- "The KR [Knowledge Representation] architectures we have considered above [logic-based systems, semantic networks and frame-based systems], together with many other proposals of a more or less similar flavour, such as production systems, constitute what may be called the `classical,' or (with some question begging) the `knowledge-based' approach to AI. Knowledge representation, in this view, involves large, complex structures of symbols, defined and assembled by hand. This approach to AI essentially derives from a line of philosophical thought running from Descartes through Leibniz, Frege, and Russell. In the late 1980s and 1990s, however, as a result of the inherent difficulty of this line of research, and of the limited progress that has been made, this approach to AI has been challenged by two alternative methodologies : neural networks, and statistical analysis of large corpora". (Davis, 2001, p. 8137-8138).

- The symbolic forms of knowledge representation thus correspond to cognitivism in psychology and to rationalism in epistemology while neural networks correspond to behaviourism in psychology and to empiricism in epistemology. They may both be said to ignore the subjective side of knowledge representation. In the symbolic form of KR the person in control of the programming tasks are defining and assembling the knowledge. Nothing is said about whether different subjects (representing different traditions or paradigms) would or should define and assemble different kinds of knowledge. In neural networks the person in control of the stimulation is determining what the organism or the system should learn. Nothing is said about how persons' criteria may be connected to subjective views and to socio-cultural factors. In both cases it is assumed without any kind of examination, that the knowledge representation is "objective". What kinds of perspective that are missing may be uncovered by the following quotation : "More recently, Clancey (1991) argues that the knowledge level has relativistic properties. A knowledge-level description is of an agent in its environment. It is an observer's theory, not representations possessed by the agent being studied" (Clancey, 1992, 743). Yes! The description of an agent's or a system's knowledge level (or generalized : a description of its knowledge) has relative properties and implies the theory of the agent or system from specific perspectives. This is a basic point in the pragmatic understanding of knowledge but it has yet to be fully implemented in theories of knowledge representation.
- In spite of the recognition of AI as applied epistemology there has not been much systematically investigation between on the one hand epistemological theories and on the other hand theories of knowledge representation. This is odd, because epistemology is the theory of knowledge and any theory of knowledge representation must be based on a theory of knowledge.
- In overviews of knowledge representation in AI (such as Davis, 2001, and Kramer and Mylopoulos, 1992) only empiricism and rationalism has been reflected as approaches. There is an obvious need to expand such overviews by a broader coverage of different epistemological positions.
- Hermeneutics has been regarded in the field of AI, first and foremost by Winograd & Flores (1987). Additional contributions include Mallery, Hurwitz and Duffy (1992); Chalmers (1999) and Fonseca and Martin (2005). There seems still to bee a need for a more direct application of historicist/hermeneutical/pragmatic approaches to knowledge representation.
- In the next section we shall very briefly suggest such an approach to knowledge representation. The main point will be put on the subjectivity of the person doing the representation in line with the thoughts introduced in the first part of this article.

Analysis of large corpora

- Among alternatives to both neural nets and symbolic KRs E. Davis briefly mentions text corpora :
- "The statistical approach to AI involves taking very large corpora of data and analyzing them in great depth using statistical techniques. These statistics can then be used to guide new tasks. The resulting data, as compared to the knowledge-based approach, are extremely shallow in terms of their semantic content, since the categories extracted must be easily derived from the data, but they can be immensely detailed and precise in terms of statistical relations. Moreover, techniques - such as maximum entropy analysis - exist that allow a collection of statistical indicators, each individually quite weak, to be combined effectively into strong collective evidence. From the point of view of knowledge representation, the most interesting data corpora are online libraries of text. Libraries of pure text exist online containing billions of words; libraries of extensively annotated texts exist containing hundreds of thousands to millions of words, depending on the type of annotation. Now, in 2001, statistical methods of natural language analysis are, in general, comparable in quality to carefully hand-crafted natural language analyzers; however, they can be created for a new language or a new domain at a small fraction of the cost in human labor" (Davis, 2001, p. 8138).
- Large corpora of data may be approached by methods related to empiricism, which seems to be what Davis is suggesting. There is an important difference, however, between traditional empiricist approaches to knowledge representation and "text corpora" approaches. In the traditional approach is represented what is considered knowledge by the person doing the representation. There is only one voice present. In large corpora of texts many voices are present (what kind of voices varies according to how the text corpus is selected, e.g. if it consists of newspapers or scholarly papers).
- Large corpora of texts consist of documents each of which is itself a system of arguments and knowledge claims. We are now in the realm of Library and Information Science (LIS) rather than in computer science in a narrow sense. What are represented in LIS are representations of documents representing knowledge (thus meta-representations). If, for example, the text corpus is an academic corpus from the same domain as the person doing the representation (e.g. computer science) then different suggestions and voices on how best to perform the task at hand is present in the very material to be (meta) represented. Different paradigms in KR contain arguments in favour of specific ways to do the representation.

- In other words : The texts to be organized are voices, which probably will contain different implications for how this knowledge should be organized (and by the way also implications for how texts should be selected in the first hand). This argument may be expanded also to cases in which the corpus is not in the domain of knowledge representation : Any document has implicit or explicit criteria of relevance, which are of importance for organizing those documents.
- If we consider the domain of Arts then the criteria for how best to represent arts is depending on what is considered (good) art. As discussed by Ørom (2003) different traditions in Arts have different implications for how arts should be represented. In corpora there are different voices, not just the programmers voice. The programmer may ignore these voices and provide knowledge representations based on his own voice alone, or the programmer may consider those voices and provide a knowledge representation, which represents a dialog between himself and the voices in the corpora. This way it is possible to use text corpora based on pragmatic epistemologies rather than empiricist epistemologies (see also Hjørland and Nissen Pedersen, in press).

Answer in Brief

1. *Write a note on representations and mappings.* **(Refer section 4.1)**
2. *What are various approaches to knowledge representation ?* **(Refer section 4.2)**
3. *Explain neural nets.* **(Refer section 4.1)**

4.3 University Questions with Answers

➡ Winter - 14

Q.1 Explain the different issues in knowledge representation. **(Refer section 4.1.2)**

➡ Summer - 15

Q.2 Explain different approaches of knowledge representation. **(Refer section 4.2)**

➡ Summer - 16

Q.3 Explain the different issues in knowledge representation. **(Refer section 4.1)**

➡ Summer - 17

Q.4 Explain property inheritance algorithm with example. **(Refer section 4.2)**

➡ Summer - 18

Q.5 Differentiate with example representation of " Instance" and "Isa" relationships. **(Refer section 4.2)** **[7]**

Q.6 Explain with example how choosing the granularity of representation and finding the right structure are crucila issues in knowledge representation ? **(Refer section 4.1.1)** **[7]**

➡ Winter - 18

Q.7 Discuss the different approaches to knowledge representation. **(Refer section 4.2)** **[4]**

➡ Winter - 19

Q.8 Explain why it is necessary to choose appropriate granularity for knowledge representation. **(Refer section 4.1)** **[3]**

Q.9 Briefly discuss declarative and procedural knowledge. **(Refer section 4.2)** **[3]**

➡ Summer - 20

Q.10 Define the following words in the context of AI :

i) Intelligence ii) Knowledge iii) Information iv) Logical reasoning. **[4]**

(Refer section 4.1)

Q.11 Briefly discuss declarative and procedural knowledge. **(Refer section 4.2)** **[3]**

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