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Unit - 3 Knowledge and Reasoning

What is Knowledge Representation

- Humans are best at understanding, reasoning and interpreting knowledge.
- Humans knows things, which is knowledge and as per their knowledge they perform various actions in the real world.
- But how machines do all these things comes under Knowledge Representation and Reasoning.

Definition:

Knowledge Representation and Reasoning (KR, KRR) is the part of AI which concerned with AI Agents thinking and how thinking contributes to intelligent Behaviour of Agents.

- It is responsible for Representing information about the Real world so that a computer can understand and can utilize this Knowledge to solve the complex Real world Problems

- Knowledge Representation is not just storing data into some database, but it also enables an intelligent machine to learn from that Knowledge and experiences so that it can behave intelligently like a human.

What to Represent ?

Following are the kind of Knowledge which needs to be represented in AI systems :

1) Object : All the facts about objects in our world Domain.
   Eg : • Guitar contains strings
   • Trumpets are brass Components.

2) Events : Events are the actions which occur in the Real-world.

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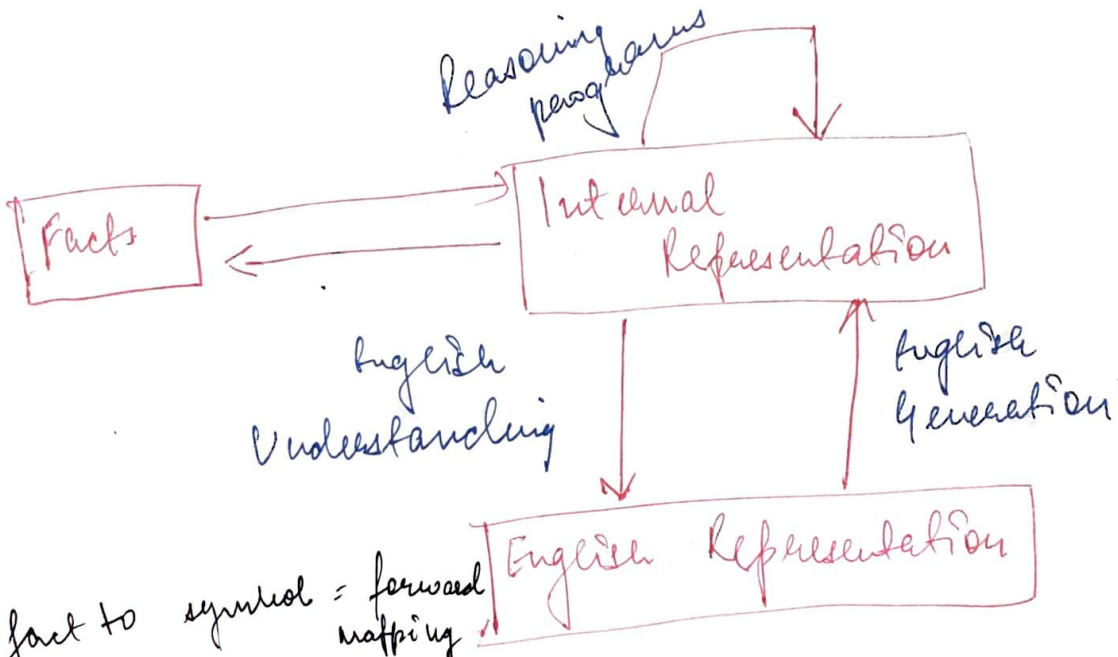
3) Facts: Facts are the truth about the Real World and what we represent.

4) Performance: It describes Behaviour which involves knowledge about how to do things.

Mapping b/w Facts & Representations:



fact to symbol = forward mapping

symbol to fact = backward mapping

Properties of Knowledge Representation Systems

1) Representational Adequacy : the Ability to represent the Required Knowledge.

2) Inferential Adequacy : The Ability to manipulate the Knowledge Represented to produce new Knowledge corresponding to that inferred from original.

3) Inferential Efficiency : The Ability to direct the Inferential mechanisms into the most productive Directions by storing Appropriate guides

4) Acquisitional Efficiency : The Ability to acquire new Knowledge using Automatic methods wherever possible rather than Reliance of Human intervention.

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Approaches to Knowledge Representation.

1) Simple Relational Knowledge: The simplest way of storing facts is to use a Relational method where each fact about a set of objects is set out systematically in columns.

2) Inheritable Knowledge: Property inheritance mechanism is applied to represent the knowledge. (Object Oriented – Represent in classes and objects).

3) Inferential Knowledge: Knowledge is Represented in form of formal logic. It can be propositional logic or predicate logic

4) Procedural Knowledge:

Simple Relational Knowledge

- It is the simplest way of storing facts.
- Each fact about a set of objects is set out systematically in columns.

Player	Height	Weight	Batting - throwing
Sachin	5.03	65	Right Right
Virat	5.10	60	left - left
Ashwin	6.01	58	Right - Right

- This representation gives little opportunity for inference
- But it can be used as the knowledge basis for inference engines

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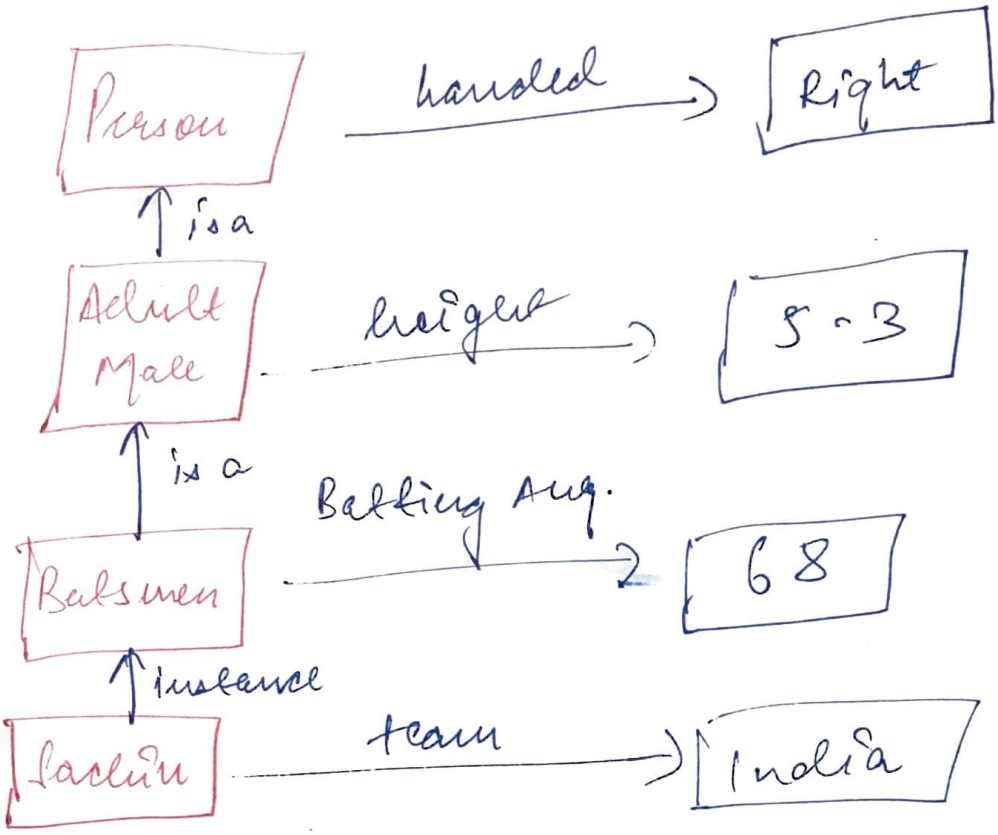
Inheritable Knowledge

- 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 organized into a hierarchy of classes.



Inferential Knowledge

- Represent knowledge as formal logic

Eg: All dogs have tails

FOL : $\forall x : dog(x) \rightarrow hasTail(x)$

Advantages:

- A set of strict rules.
  - → can be used to derive more facts.
  - → Truths of new statements can be verified.
  - → Guaranteed correctness

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Many inference procedures available to implement standard rules of logic

Procedural Knowledge

- Knowledge encoded in some procedures
  → small programs that know how to do specific things, how to proceed.

Advantages

- Heuristic or domain specific knowledge can be Represented
- Extended logical inferences, such as default Reasoning facilitated.
- Side effects of Actions may be modeled Some rules may become false in time. Keeping track of this in large systems may be tricky.

Disadvantages

- Completeness : All cases may not be represented
- Consistency : All deductions may not be correct
- Modularity is sacrificed

Issues in Knowledge Representation

1) Important Attributes
2) Relationship Among Attributes.
3) Granularity of Representation
4) Set of Objects.
5) Finding Right Structure

1) Important Attributes

- Are there any attributes that occur in almost every problem domain?
- If there are, we need to make sure that they are handled Appropriately.
- There are 2 Attributes
  - Instance } These attributes are important
  - isa } bcoz they support properly Inheritance.

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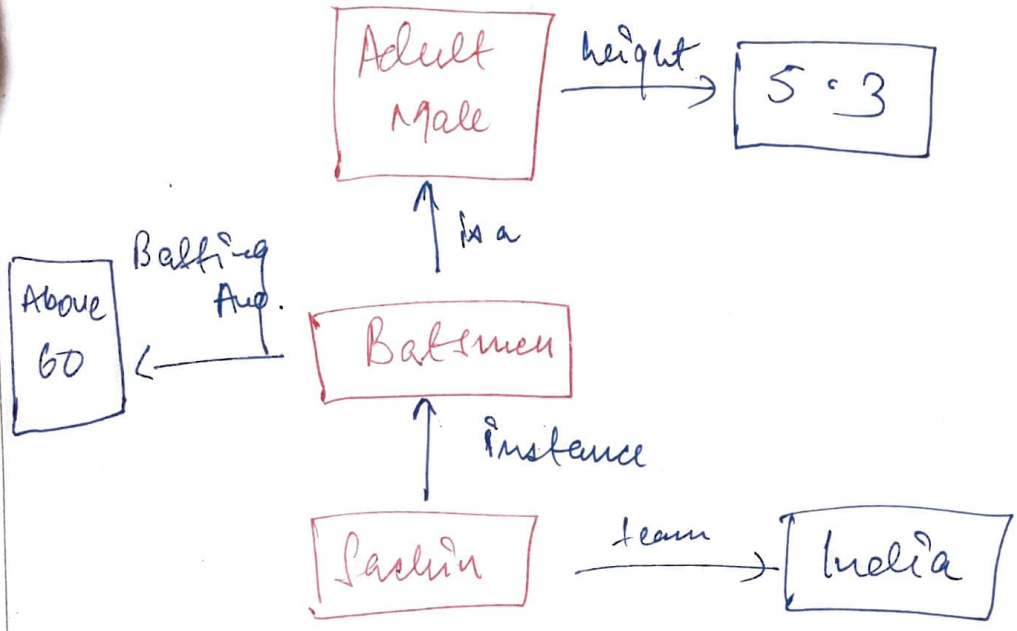
Instance indicates class Membership

is a indicates class Inclusion



2) Relationships among Attributes.

Are there any important relationships that exist among attributes of objects.

- ~~There~~
- There are 4 properties of Attributes :

→ Inverses → Existence in an is a hierarchy.

→ Techniques for Reasoning about Values.
→ Single Valued Attributes

3) Choosing the Granularity of Representation

- At what level should knowledge be Represented?
- Is there any good set of primitives (basic structure) in which all knowledge can be broken down?
- Is it helpful to use such primitives?
- Primitives are fundamental concepts such as holding, seeing - playing...

Example.

Consider the following fact

Raju Spotted Rani

we could represent this as

Spotted (agent (Raju), object (Rani))

Now we have Question as:

→ Who spotted Rani? → We can discover the Ans as Raju.

→ Did Raju see rani? → We cannot discover the Answer. because the primitive is Spotted

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In order to discover the answer, we have added other facts such as

Spotted (x, y) → Saw (x, y)

- An Alternative solution to this problem is to represent the fact that spotting is really a special type of seeing explicitly in the representation of fact

we might write something as :

Saw (agent (Raju), object (Rani), timespan (briefly))

- In this representation we have broken the idea of spotting apart into more primitive concepts of seeing and timespan.

4) Representing set of objects

How should set of objects be represented ?

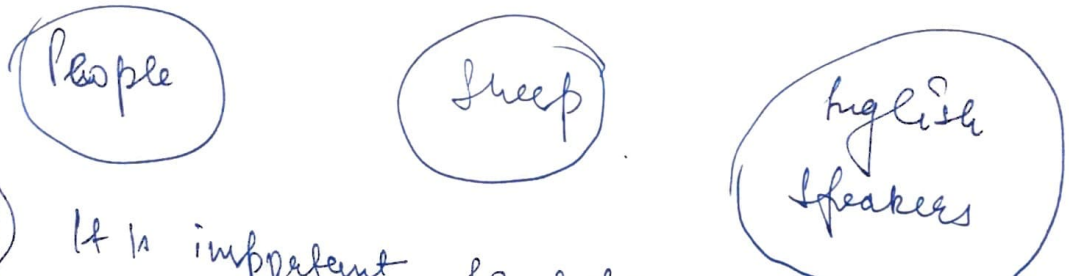
- It is very important to represent set objects because of 2 Reasons:

1) There are some properties that are true for the sets but not true for the individual member of set.

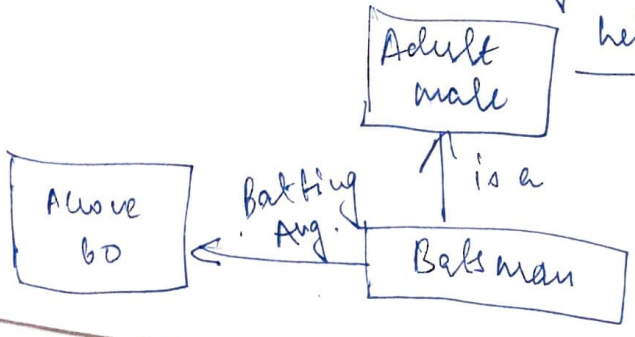
Eg:

There are more sheep than people in Australia

English speakers can be found all over the world



2) It is important to represent set of objects is that if a property is true for all (or even most) elements of a set, then it is more efficient to associate it explicitly with every element of a set.



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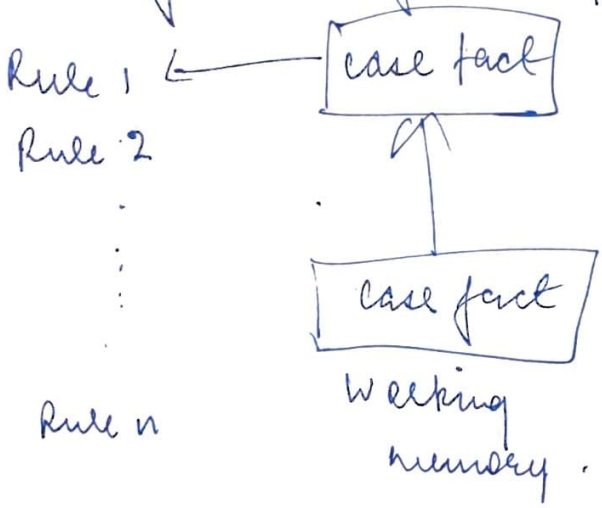
5) Finding the Right Structure as Needed.

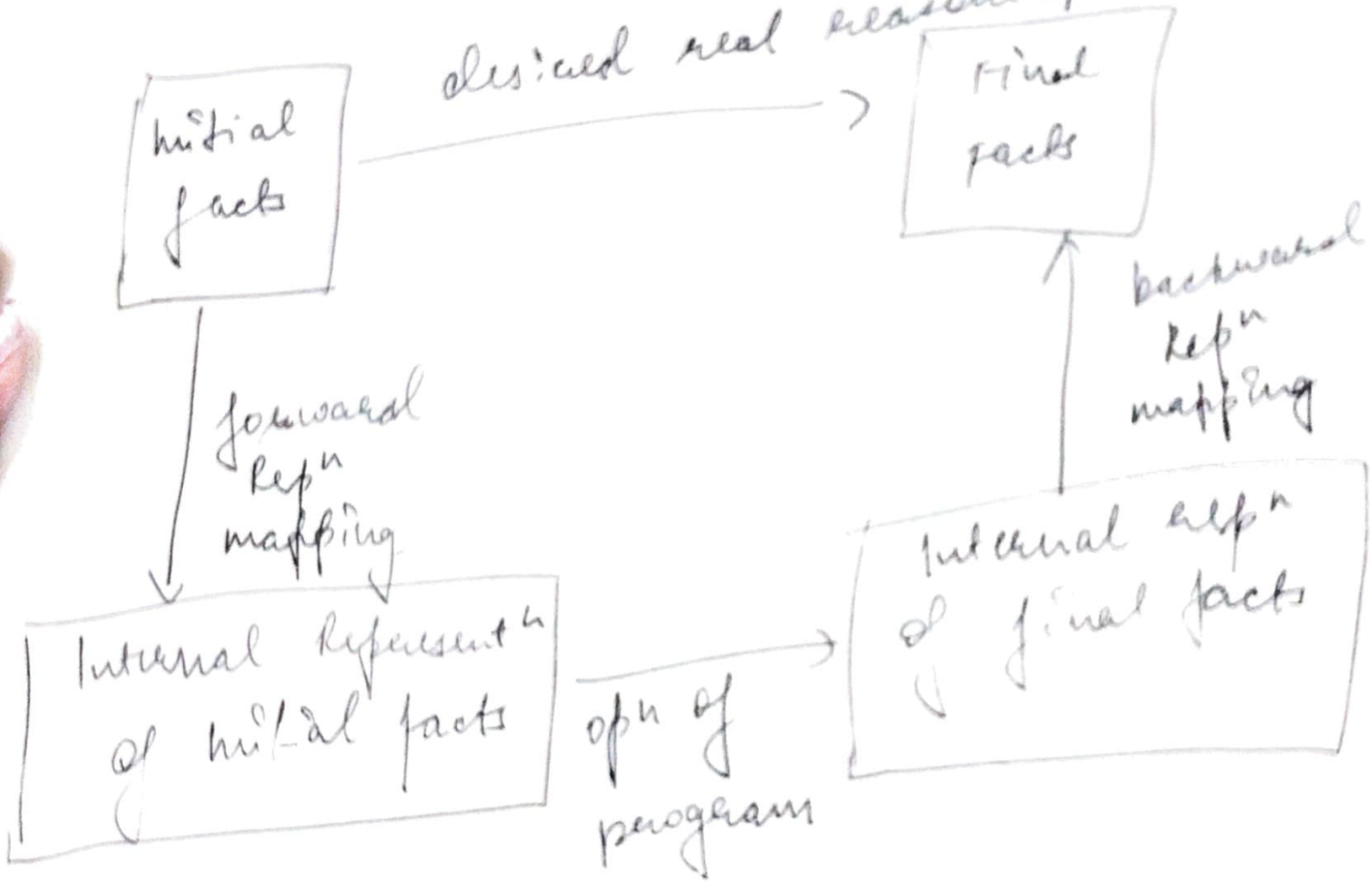
- given a large Amount of knowledge stored in a Database. How can relevant parts be accessed when they are needed?
- Problem of matching rules against state descriptions during the problem solving process



① How to perform an initial selection of the most appropriate structure.
② How to fill in appropriate details from current situation.

③ how to find either structure if the one chosen initially turns out not to be appropriate

④ when to create and remember a new structure



Ram is Shyam and brothers

Brothers (Ram, Shyam)

↓

Reasoning prog.

↓

Shyam is Brother of Ram - Symbolic

↓

final fact.