Artificial Intelligence

Prepared

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Class Discussion Topic

Textbook:

- Elaine Rich, Kevin Knight and Shivashankar B Nair, Artificial Intelligence, 3rd ed. New Delhi: Tata McGraw-Hill, 2012.

Class Discussion Topic(CDT):

- Review of Knowledge Representation Issues: Knowledge representations and mappings, Approaches to knowledge representation and Issues in knowledge representation

Lecture Level Learning Outcome

After completion of this lecture, students will be able to…

- LO1:Learn about Knowledge Representation Issues: Knowledge representations and mappings.
- LO2:Learn about knowledge representation approaches.
- LO3:Learn about Knowledge Representation Issues

What is Knowledge Representation?

- Knowledge Representation in AI describes the representation of knowledge.
- Basically, it is a study of how the beliefs, intentions, and judgments of an intelligent agent can be expressed suitably for automated reasoning.
- One of the primary purposes of Knowledge Representation includes modeling intelligent behavior for an agent.
- Knowledge Representation and Reasoning (KR, KRR) represents information from the real world for a computer to understand and then utilize this knowledge to solve complex real-life problems like communicating with human beings in natural language.
- Knowledge representation in AI is not just about storing data in a database, it allows a machine to learn from that knowledge and behave intelligently like a human being.

What is Knowledge Representation?

- The different kinds of knowledge that need to be represented in AI include:
- Objects
- Events
- Performance
- Facts
- Meta-Knowledge
- Knowledge-base
- Now that you know about Knowledge representation in AI, let's move on and know about the different types of Knowledge.

Mapping between facts and representation

- Knowledge is a collection of “Facts ” from some domain. We need a representation of facts that can be manipulated by a program. Normal English is insufficient, too hard currently for a computer program to draw inferences in natural languages.

- Thus some symbolic representation is necessary. Therefore, we must be able to map “facts to symbols” and “symbols to facts” using forward and backward representation mapping.

Example

Example : Consider an English sentence

Facts	***Representations***
◇ Spot is a dog	A *fact* represented in *English sentence*
◇ dog (Spot)	Using *forward mapping function* the above *fact* is represented in *logic*
◇ ∀ **x : dog(x) → hastail (x)**	A *logical representation* of the *fact* that *"all dogs have tails"*

Now using ***deductive mechanism*** we can generate a new representation of object :

◇ hastail (Spot)	A new object representation
◇ Spot has a tail *[it is new knowledge]*	Using *backward mapping function* to generate English sentence

Representation of Facts

- **Forward and Backward representation**

The forward and backward representations are elaborated below :

- The doted line on top indicates the abstract reasoning process that a program is intended to model.
- The solid lines on bottom indicates the concrete reasoning process that the program performs.

Approaches to knowledge representation

1. Inferential Knowledge

   Facts represented in a logical form, which facilitates reasoning.An inference engine is required.

Ex: 1. “Marcus is a man”

   2. “All men are mortal” Implies:

   3. “Marcus is mortal”

2. Procedural Knowledge:

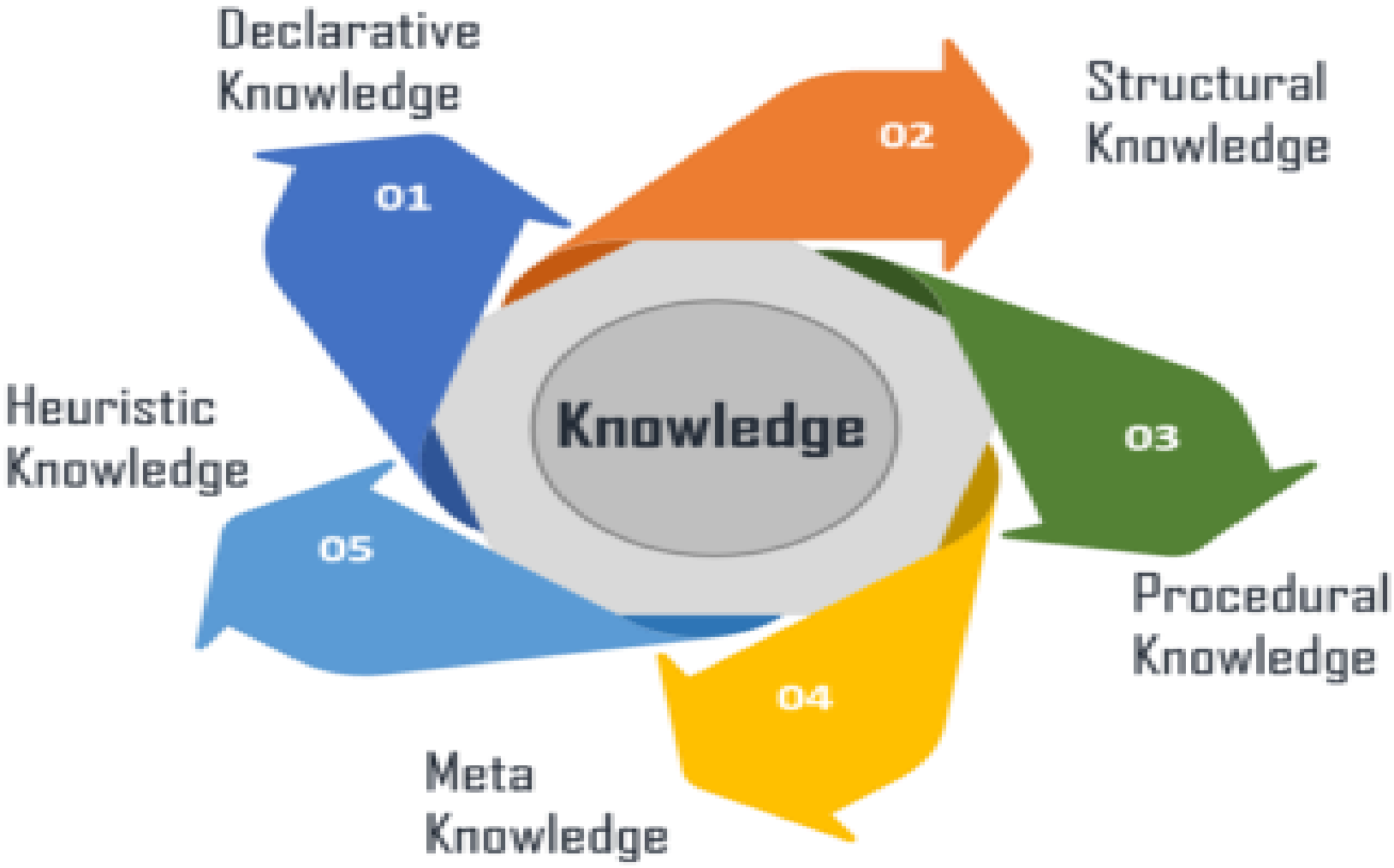
Representation of “how to make it” rather than “what it is”.

May have inferential efficiency, but no inferential adequacy and acquisitional efficiency.

Ex: Writing LISP programs

Different Types of Knowledge

There are 5 types of Knowledge such as



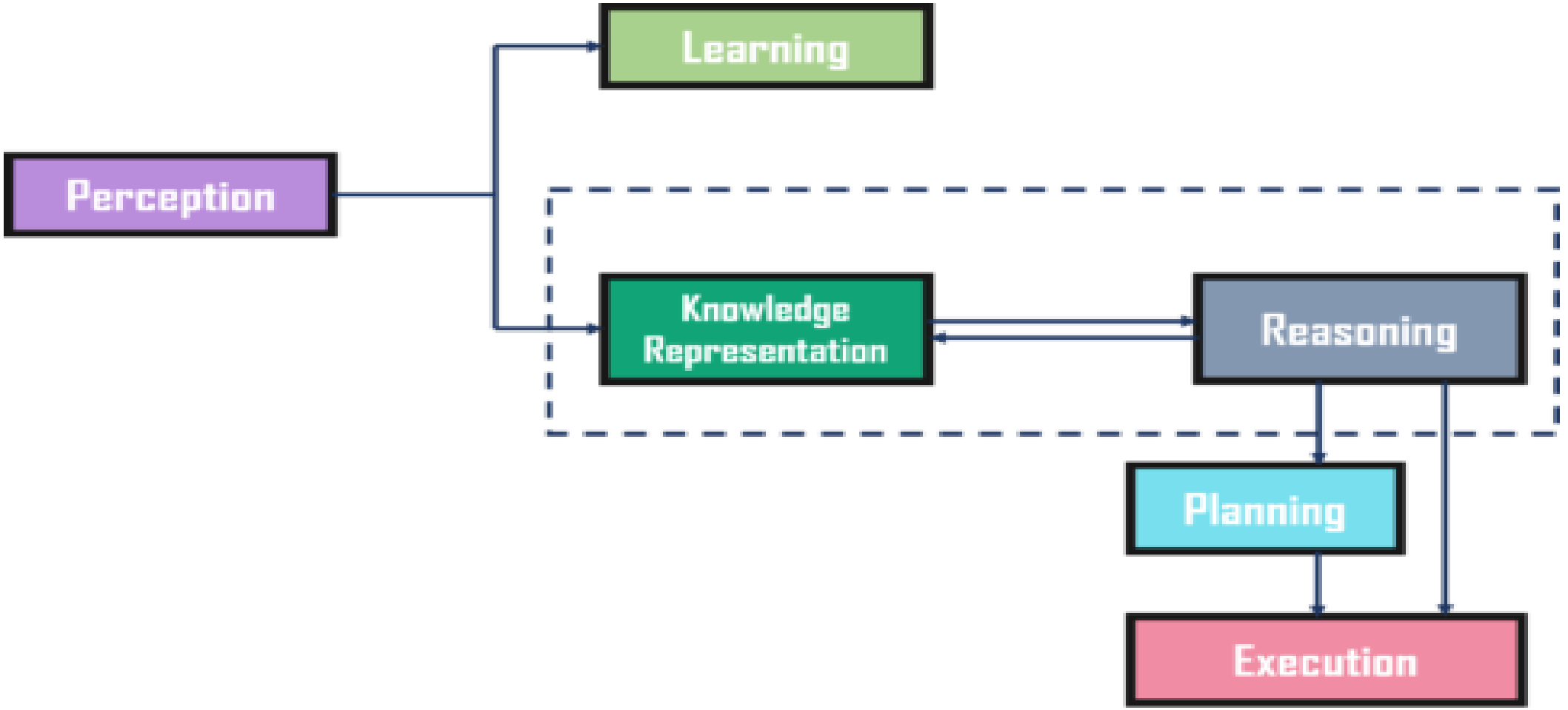
Important types of Knowledge

- Declarative Knowledge – It includes concepts, facts, and objects and expressed in a declarative sentence.
- Structural Knowledge – It is a basic problem- solving knowledge that describes the relationship between concepts and objects.
- Procedural Knowledge – This is responsible for knowing how to do something and includes rules, strategies, procedures, etc.
- Meta Knowledge – Meta Knowledge defines knowledge about other types of Knowledge.
- Heuristic Knowledge – This represents some expert knowledge in the field or subject.

Cycle of Knowledge Representation in AI

- Artificial Intelligent Systems usually consist of various components to display their intelligent behavior. Some of these components include:
- Perception
- Learning
- Knowledge Representation & Reasoning
- Planning
- Execution

Example to show the different components of the system and how it works



Example to show the different components of the system and how it works

- The Perception component retrieves data from the environment. Find out the source of noises if any. Also, it defines how to respond when any sense has been detected.
- Then, there is the Learning Component that learns from the captured data by the perception component. The goal is to build computers that can be taught instead of programming them. Learning focuses on the process of self- improvement.
- In order to learn new things, the system requires knowledge acquisition, inference, acquisition of heuristics, faster searches, etc.
- The main component in the cycle is Knowledge Representation and Reasoning which shows the human-like intelligence in the machines. Knowledge representation is all about understanding intelligence.

- Instead of trying to understand or build brains from the bottom up, its goal is to understand and build intelligent behavior from the top-down and focus on what an agent needs to know in order to behave intelligently.
- Also, it defines how automated reasoning procedures can make this knowledge available as needed.
- The Planning and Execution components depend on the analysis of knowledge representation and reasoning.
- Here, planning includes giving an initial state, finding their preconditions and effects, and a sequence of actions to achieve a state in which a particular goal holds.
- Now once the planning is completed, the final stage is the execution of the entire process.

Issues in Knowledge Representation

1.Important Attributes: Isa and instance attributes.

2.Relationships among attributes: inverses, existence in a Isa hierarchy, single-valued attributes, techniques for reasoning about values.

3.Choosing the Granularity: High-level facts may not be adequate for inference. Low-level primitives may require a lot of storage.

Ex: "john spotted sue"

[representation: spotted(agent(john),object(sue))]

Q1: "who spotted sue?" Ans1: "john".

Q2: "Did john see sue?" Ans2: NO ANSWER!!!!

Add detailed fact: spotted(x,y)-->saw(x,y) then Ans2: "Yes".

Issues in Knowledge Representation

4.Representing Set of Objects

5.Finding the right structure as needed

Ex:

word “fly” can have multiple meanings:

“John flew to new york”

“John flew into a rage” [idiom]

“john flew a kite”

Propositional logic

Statements used in mathematics.

Proposition :is a declarative sentence whose value is either true or false.

Examples:

- “The sky is blue.” [Atomic Proposition]
- “The sky is blue and the plants are green.”
- [Molecular/Complex Proposition]
- “Today is a rainy day” [Atomic Proposition]
- “Today is Sunday” [Atomic Proposition]
- “ 2*2=4” [Atomic Proposition]

Terminology used in propositional algebra

Statement: sentence that can be true/false.

Properties of statement:

Satisfyability : a sentence is satisfyable if there is an interpretation for which it is true.

Eg : we wear woollen cloths”

Contradiction : if there is no interpretation for which sentence is true.

Eg : “Japan is capital of India”

Validity : a sentence is valid if it is true for every interpretation.

Eg : “Delhi is the capital of India”

A* Search Algorithm

Example:

“I will get wet if it rains and I go out of the house”

Let Propositions be:

W : “I will get wet “

R : “it rains “

S : “I go out of the house”

$(S \wedge R) \rightarrow W$

Using Propositional Logic

- Representing simple facts
- It is raining RAINING
- It is sunny SUNNY
- It is windy WINDY
- If it is raining, then it is not sunny RAINING □ □SUNNY

Normal Forms in propositional Logic

1. Conjunctive normal form (CNF):

e.g. $(P \vee Q \vee R) \wedge (P \vee Q) \wedge (P \vee R) \wedge P$

It is conjunction ($\wedge$) of disjunctions ($\vee$)

Where disjunctions are:

1. $(P \vee Q \vee R)$
2. $(P \vee Q$
3. $(P \vee R)$
4. P

Disjunctive normal form (DNF)

e.g. $(P \wedge Q \wedge R) \vee (P \wedge Q) \vee (P \wedge R) \vee P$

It is disjunction ($\vee$)of conjunctions ($\wedge$)

Procedure to convert a statement to CNF

1. Eliminate implications and biconditionals using formulas:

$(P \Leftrightarrow Q) \Longrightarrow (P \rightarrow Q) \wedge (Q \rightarrow P)$

$P \rightarrow Q \Rightarrow \neg P \vee Q$

2. Apply De-Morgan's Law and reduce NOT symbols so as to bring negations
before the atoms. Use:

$\neg (P \vee Q) \Longrightarrow \neg P \wedge \neg Q$

$\neg (P \wedge Q) \Longrightarrow \neg P \vee \neg Q$

3. Use distributive and other laws & equivalent formulas to obtain Normal forms.

Learning Outcomes(LOs)

Having completed the discussion on Knowledge representations and mappings, Approaches to knowledge representation, Issues in knowledge representation, now, students should be able to…

- ✓ LO1: Learn about knowledge representation & mappins.
- ✓ LO2: Learn about knowledge representation approaches.
- ✓ LO3: Learn about Knowledge Representation Issues

Questions

1.Represent the Resolution in propositional logic “If it is Hot then it is Humid. If it is humid then it will rain. It is hot.” prove that “it will rain.”

2. Write the predicate logic for the statement “Any person who is respected by every person is a king”

3. Represent the following sentences in predicate logic and prove that “John likes Peanuts” using backward reasoning.

(1) John likes all kinds of food.

(2) Apples are food.

(3) Anything any one eats and is not killed by is food.

(4) Bill eats Peanuts and is alive.

4. Predicate logic is used as a way of representing knowledge, apply the predicate logic for the following

1. Marcus was a man.

2. Marcus was a Pompeian.

3. All Pompeians were Romans.

4. Caesar was a ruler.

5. All Pompeians were either loyal to Caesar or hated him.

6. Everyone is loyal to someone.

7. People only try to assassinate rulers they are not loyal to.

8. Marcus tried to assassinate Caesar

5. The knowledge can be expressed in the various forms to the inference engine in the computers to solve the problems in context of the rule Differentiate declarative versus procedural knowledge using suitable examples?

Thank you !!!