Artificial Intelligence

Lecture - 11

Knowledge Representation

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Lecture Outlines

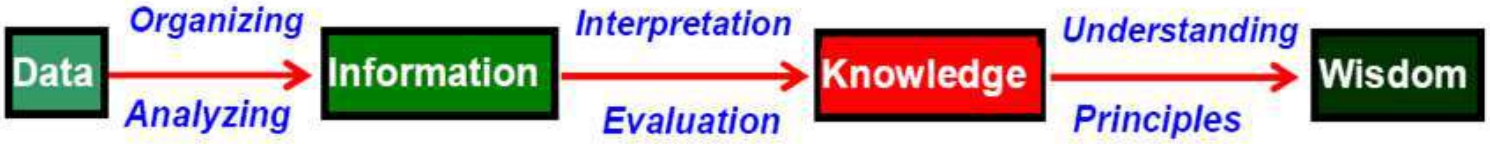
- …
- Knowledge Progression
- Knowledge (DIKW) Model
- Techniques of KR
- Approaches to KR in AI

Knowledge Progression...

- Knowledge is a progression that starts with data which is of limited utility.
  - By **organizing or analyzing the data**, we understand what the data means, and this **becomes information**.
  - The interpretation or evaluation of information **yield knowledge**.
  - An understanding of **the principles embodied within the knowledge is wisdom**.

Knowledge Progression

- **Data** is viewed as collection of *disconnected facts.*
  - Example : It is raining.
- **Information** emerges when *relationships among facts are* established and understood; Provides answers to *"who", "what", "where", and "when".*
  - Example : The temperature dropped 15 degrees and then it started raining.
- **Knowledge** emerges when relationships among patterns are identified and understood; Provides answers as "how" .
  - Example : If the humidity is very high and the temperature drops substantially, then atmospheres is unlikely to hold the moisture, so it rains.
- **Wisdom** is the pinnacle of understanding, uncovers the principles of relationships that describe patterns. Provides answers as "why" .
  - Example : Encompasses understanding of all the interactions that happen between raining, evaporation, air currents, temperature gradients, changes, and raining.



Knowledge (DIKW) Model…

- The model tells, that as the degree of "**connectedness**" and "**understanding**" increase, we progress **from data through information and knowledge to wisdom**.

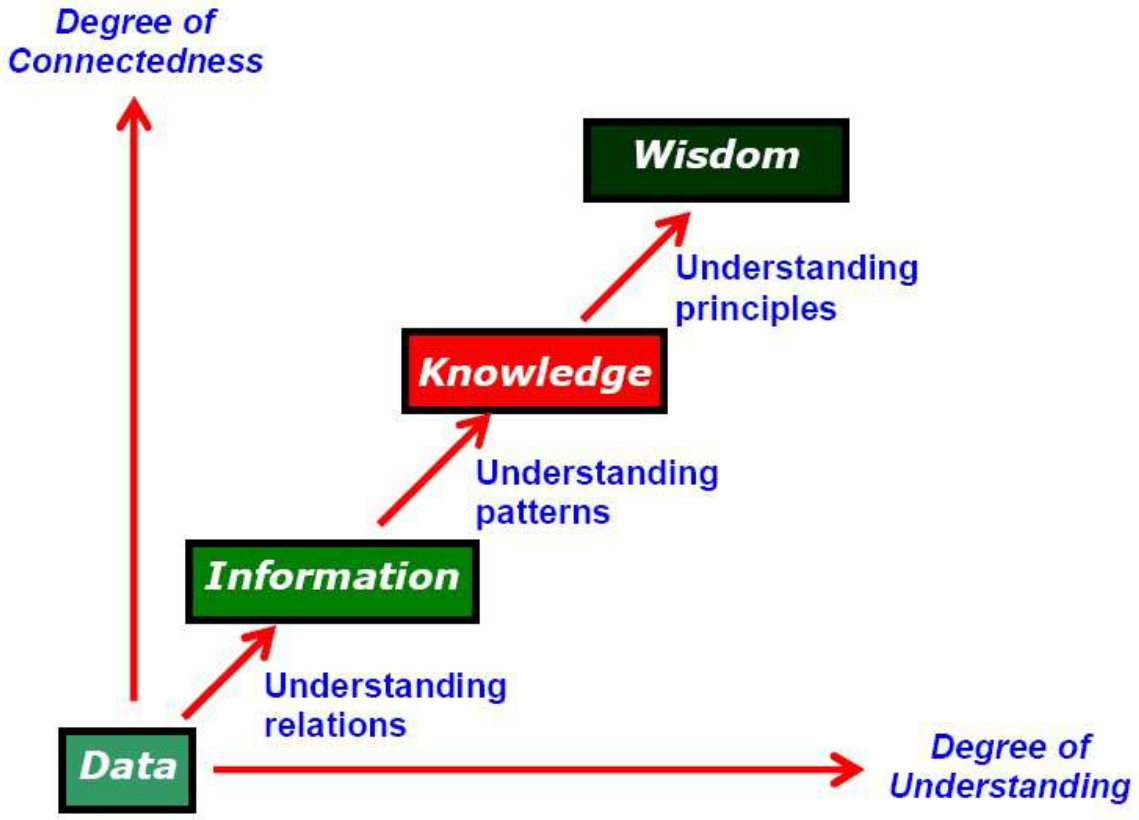
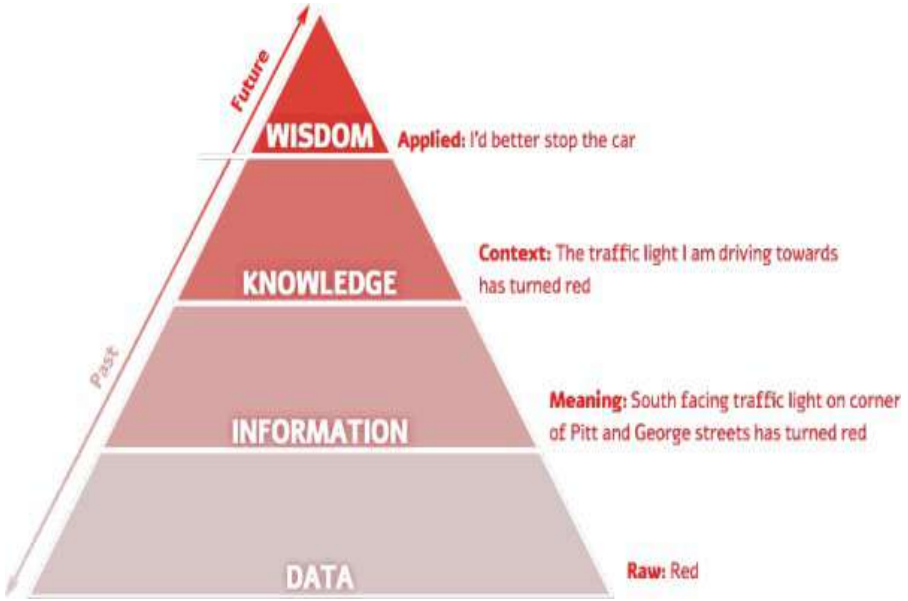


Fig. Knowledge Model

Knowledge (DIKW) Model

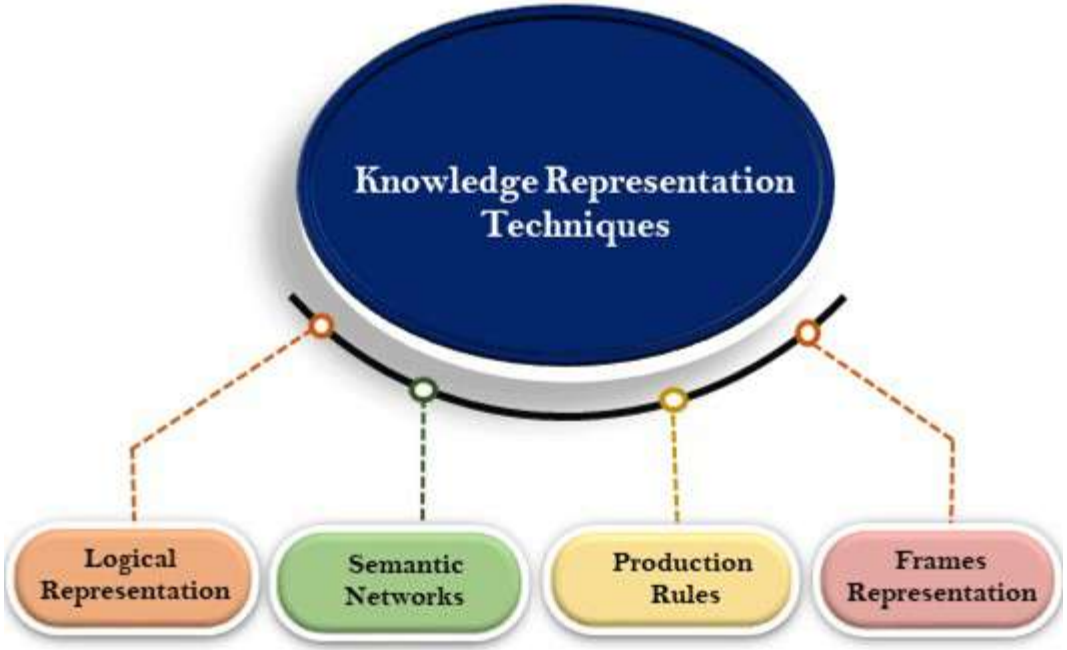
- The model represents **transitions** and **understanding**. The **transitions** are from data, to information, to knowledge, and finally to wisdom; The **understanding** support the transitions from one stage to the next stage.

  - The distinctions between data, information, knowledge, and wisdom are not very discrete.
  - **Data and information** deal with the past; they are based on the gathering of facts and adding context.
  - **Knowledge** deals with the present that enable us to perform.
  - **Wisdom** deals with the future, acquire vision for what will be, rather than for what is or was.



Techniques of KR…

- There are mainly four ways of knowledge representation which are given as follows:
  - **Logical Representation**
  - **Semantic Network Representation**
  - **Frame Representation**
  - **Production Rules**



Techniques of KR…

- **Logical Representation**
  - Logical representation is a language with some concrete rules which deals with propositions and has no ambiguity in representation. Logical representation means drawing a conclusion based on various conditions. It consists of precisely defined syntax and semantics which supports the sound inference. Each sentence can be translated into logics using **syntax and semantics**.

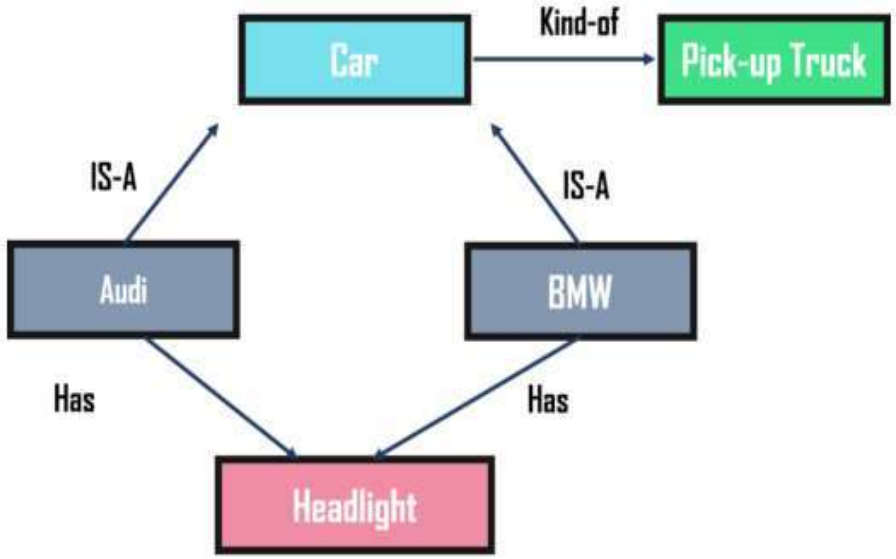
- Logical representation can be categorized into mainly two logics:
  1. **Propositional Logics**
  2. **Predicate logics**

Syntax	Semantics
• It decides how we can construct legal sentences in logic. • It determines which symbol we can use in knowledge representation. • Also, how to write those symbols.	• Semantics are the rules by which we can interpret the sentence in the logic. • It assigns a meaning to each sentence.

Techniques of KR…

- **Semantic Network Representation**
  - Semantic networks work as an **alternative** of **predicate logic** for knowledge representation. In Semantic networks, you can represent your knowledge in the form of graphical networks. This network consists of nodes representing objects and arcs which describe the relationship between those objects. Also, it categorizes the object in different forms and links those objects.

- This representation consist of two types of relations:
  - **IS-A relation (Inheritance**
  - **Kind-of-relation**



Techniques of KR…

- **Frame Representation**
  - A frame is a record like structure which consists of a collection of attributes and its values to describe an entity in the world. Frames are the AI data structure which divides knowledge into substructures by representing stereotypes situations. It consists of a collection of slots and slot values. These slots may be of any type and sizes. Slots have names and values which are called facets.
  - **Facets:** The various aspects of a slot is known as **Facets**. Facets are features of frames which enable us to put constraints on the frames.
  - Example: IF-NEEDED facts are called when data of any particular slot is needed. A frame may consist of any number of slots, and a slot may include any number of facets and facets may have any number of values.
  - A frame is also known as **slot-filter knowledge representation** in artificial intelligence.

Techniques of KR…

- **Frame Representation**

Example: 1

Let's take an example of a frame for a book

Slots	Filters
Title	Artificial Intelligence
Genre	Computer Science
Author	Peter Norvig
Edition	Third Edition
Year	1996
Page	1152

Techniques of KR…

- **Production Rules**
  - Production rules system consist of (**condition, action**) pairs which mean, "If condition then action". It has mainly three parts:
    - **The set of production rules**
    - **Working Memory**
    - **The recognize-act-cycle**
  - In production rules agent checks for the condition and if the condition exists then production rule fires and corresponding action is carried out. The condition part of the rule determines which rule may be applied to a problem. And the action part carries out the associated problem-solving steps. This complete process is called a recognize-act cycle.
  - If there is a new situation (state) generates, then multiple production rules will be fired together, this is called conflict set. In this situation, the agent needs to select a rule from these sets, and it is called a conflict resolution.

Techniques of KR

- **Production Rules**

Example:

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

Requirements for KR System

- A good knowledge representation system must possess the following properties.

1. Representational Accuracy:

KR system should have the ability to represent all kind of required knowledge.

2. Inferential Adequacy:

KR system should have ability to manipulate the representational structures to produce new knowledge corresponding to existing structure.

3. Inferential Efficiency:

The ability to direct the inferential knowledge mechanism into the most productive directions by storing appropriate guides.

4. Acquisitional efficiency:

The ability to acquire the new knowledge easily using automatic methods.

Approaches to KR in AI…

- There are different approaches to knowledge representation such as:
  1. **Simple Relational Knowledge**
  2. **Inheritable Knowledge**
  3. **Inferential Knowledge**

Approaches to KR in AI…

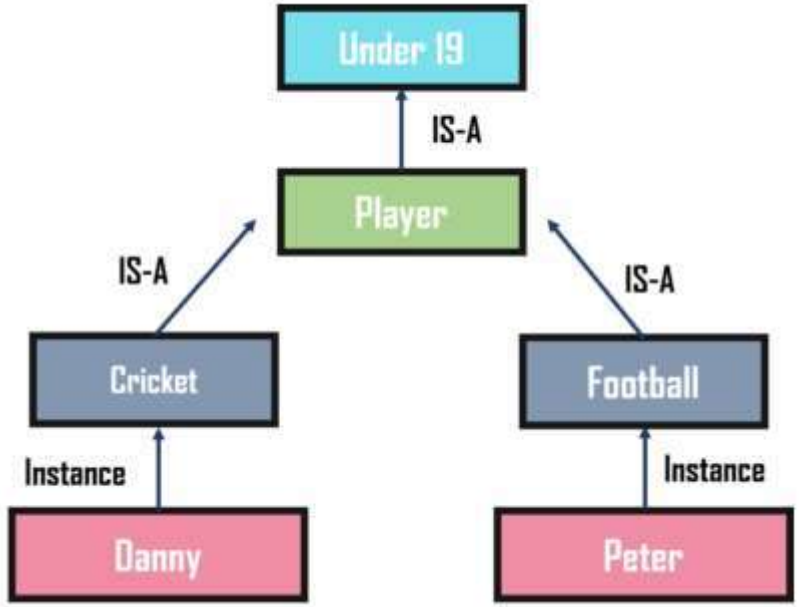
- **Simple Relational Knowledge**
  - It is the simplest way of storing facts which uses the relational method. Here, all the facts about a set of the object are set out systematically in columns.
  - Also, this approach of knowledge representation is famous in database systems where the relationship between different entities is represented. Thus, there is little opportunity for inference.

Example:

Name	Age	Emp ID
John	25	100071
Amanda	23	100056
Sam	27	100042

Approaches to KR in AI…

- **Inheritable Knowledge**
  - In the inheritable knowledge approach, all data must be stored into a hierarchy of classes and should be arranged in a generalized form or a hierarchal manner.
  - Also, this approach contains inheritable knowledge which shows a relation between instance and class, and it is called instance relation. In this approach, objects and values are represented in Boxed nodes.
  - Example:



Approaches to KR in AI

- **Inferential Knowledge**
  - The inferential knowledge approach represents knowledge in the form of formal logic. Thus, it can be used to derive more facts. Also, it guarantees correctness.

Example:

Statement 1: John is a cricketer.

Statement 2: All cricketers are athletes.

Then it can be represented as;

Cricketer(John)

$\forall x$ Cricketer (x) $\rightarrow$ Athelete (x)

Knowledge Representation

THE END