Knowledge Representation

Amrita Chaturvedi
Department of Computer Science and Engineering
IIT Kanpur.
Topics Covered

• What is Knowledge?
• Why do we need Knowledge Representation?
• Types of Knowledge
• Home Work Exercise
What is Knowledge?

- Knowledge is understanding of a subject area.

- Concepts and facts

- Properties of concepts

- Mechanisms for how to combine concepts to solve problems

- Relationships between concepts
What is Knowledge? (2)

- Difference between data, information and knowledge:
  - Data: Primitive verifiable facts. Example: name of novels available in a library.
  - Information: Analyzed data. Example: The novel that is frequently asked by the members of library is “Harry Potter and the Chamber of Secrets”.
  - Knowledge: Analyzed information that is often used for further information deduction. Example: Since the librarian knows the name of the novel that is frequently asked by members, s/he will ask for more copies of the novel the next time s/he places an order.
Why do we need Knowledge Representation?

- Unlike human mind, computers cannot acquire and represent knowledge by themselves.
- It is complicated to machine process a knowledge represented in natural language.
- Human knowledge is of different types.
- Knowledge manipulation involves:
  - Knowledge acquisition: gathering, structuring and organizing knowledge.
  - Knowledge storing: putting the knowledge into computer.
  - Knowledge retrieval: getting the knowledge when needed.
  - Reasoning: gives conclusion, inference or explanation.
Types of Knowledge

• Procedural Knowledge
• Declarative Knowledge
• Meta – Knowledge
• Heuristic Knowledge
• Structural Knowledge
• Inexact and Uncertain Knowledge
• Commonsense Knowledge
• Ontological Knowledge
Types of Knowledge (2)

- **Procedural Knowledge**: rules, strategies, agendas, procedures.
  - Also known as imperative knowledge
  - Is knowing *How to do something*
  - Can be directly applied to a task
  - Depends upon the task on which it can be applied
  - Less general
  - Example: How to cook vegetable or how to prepare a particular dish is procedural knowledge.
Types of Knowledge (3)

- **Declarative Knowledge**: concepts, objects, facts.
  - Also known as descriptive knowledge
  - Is knowing *about something*
  - Is expressed in declarative sentences
  - Consists of facts
  - More general than procedural knowledge
  - Example: The first step in cooking a vegetable is chopping it.
  - Example 2: To prepare a dish one needs to gather its ingredients.
## Types of Knowledge (4)

More Examples of Declarative and Procedural Knowledge

<table>
<thead>
<tr>
<th>Procedural Knowledge</th>
<th>Declarative Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process of planting herbs</td>
<td>Knowing something about herbs</td>
</tr>
<tr>
<td>Procedure of treating the crops of a particular disease</td>
<td>Description of symptoms of a plant disease</td>
</tr>
<tr>
<td>Procedure to harvest a crop</td>
<td>Knowledge of the month when a crop should be harvested</td>
</tr>
<tr>
<td>Draw a line graph from a data set</td>
<td>Familiarity with the data sets and line graphs</td>
</tr>
<tr>
<td>Procedure to register in a video lecture</td>
<td>Knowledge acquired in a video lecture</td>
</tr>
<tr>
<td>Type a text in a computer using a keyboard</td>
<td>Knowledge about the placement of keys in a keyboard</td>
</tr>
</tbody>
</table>
Types of Knowledge (5)

• Meta - Knowledge: knowledge about other types of knowledge.
  ◦ Example: bibliographic data, catalogue of books
  ◦ May be used to reveal patterns in research, relationship between researchers and identify contradictory results

• Heuristic Knowledge: rules of thumb based on previous experience, awareness of approaches that are likely to work but which are not guaranteed.
  ◦ Example: Knowledge about the web navigation habits of an individual
  ◦ An educated guess for example, about the search needs of a person
Types of Knowledge (6)

• Structural Knowledge: rule sets, concept relationships, concept-to-object relationships.
  – Is basic to problem solving
  – Describes relationships between concepts like kind of, part of and groupings.
  – Example: Mango is a kind of fruit. Fruit is a kind of crop. Crop information is part of agricultural knowledge.
Types of Knowledge (7)

  – Characterizes situations in which information is imprecise, unavailable, incomplete, random or ambiguous
  – Example: Rumors about something or someone, terms like ‘little’, ‘too much’, ‘warm’, ‘more or less’ etc.
Types of Knowledge (8)

• Commonsense Knowledge: default propositions, approximate concepts and theories, general hierarchies and analogies.
  ◦ Denotes vast amount of human knowledge about the world that cannot be stated in precise theories
  ◦ Collection of facts and information that an ordinary person is expected to know
  ◦ Example: The shape and color of an apple, knowledge about human emotions, reflexes etc
Types of Knowledge (9)

• Ontological Knowledge: concepts, relationships between concepts, axioms, constraints
  – Describes the categories of things in a domain
  – Example: Ontological knowledge about crop diseases contains concepts like crop, disease, symptoms and management
  – Overlaps with other categories of knowledge like declarative and structural
Home Work Exercise

• Specify the following statements as declarative or procedural:
  ◦ Draw an oil painting
  ◦ Describe the characteristics of an apple
  ◦ What is the procedure to make mango shake
  ◦ Describe the steps of free style stroke in swimming
  ◦ What is swimming
  ◦ Describe the nature of your friend
  ◦ Describe the process of making a custard
Thank You