Knowledge Representation

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What is Knowledge?

- Knowledge is *information or understanding (theoretical or practical)* about some domain or subject area, or about how to *do* something.

- Knowledge can take many forms. Some simple examples are:
  - Eve is a female
  - Adam is a male.
  - Females with children are mothers.
  - Mothers are females, fathers are males.

Knowledge Representation

- This issue arises both in cognitive science and AI
- Cognitive Science:
  - How people store and process information
- AI:
  - Store knowledge so that programs can process it and simulate human intelligence
  - Facilitate inference and draw conclusions

Some in issues in KR

- How do people represent knowledge?
- What is the nature of the knowledge?
- Should it be domain independent or specialized to a particular field?
- How expressive is it?
- Declarative or procedural scheme?

Knowledge Representation Schemes

- Logical representation
  - Uses expressions in formal logic to represent knowledge
  - Inference engine applies this knowledge to problem instances
  - Predicate Calculus is widely used logical representation scheme
  - Prolog is used mostly to implement this scheme
- Procedural representation
  - Uses set of instructions for solving problem
  - Rule based system (If else structure)
- Network representation
  - Captures knowledge as a graph (nodes and arcs)
  - Semantic networks is famous network representation scheme
- Structured representation
  - Extends network by allowing each node to be a complex structure
  - Example: Frames

How to *Represent* Knowledge?

- Why don't we use natural languages to represent Knowledge?
- Natural language is certainly expressive enough
- Too ambiguous for automated reasoning.
  - No clear semantics.
  - Syntax ambiguous
  - Too many ways of expressing the same thing

Databases

- Simple databases are commonly used to good effect in Computer Science.
- They can be use to store and manipulate virtually any kind of information.
- You can store very large data in the databases along with their relationships.
- But storage and display are not enough as we also need to *manipulate* the knowledge

Disadvantages of Databases as a KR

- *Disadvantages*
  - Only simple aspects of the problem domain can be accommodated.
- We can represent entities, and relationships between entities, but not much more.
- Reasoning is very simple. Basically the only reasoning possible is simple lookup, and we usually need more sophisticated processing than that.

Features of a Knowledge Representation Scheme

- Representational adequacy
- Inferential adequacy
- Inferential efficiency
- Well-defined syntax & semantics
- Naturalness

Basic Approaches

- The widely used knowledge representation approaches are:
  - Logic
  - Rule-based systems (AKA *production systems*)
  - Expert systems
  - Semantic networks and frames