Perspectives

There are at least three broad perspectives one can lend to the field of knowledge representation and reasoning (KRR). It is likely that all three perspectives will be presented, regardless of the over all thematic organization of the course.

- **KR as applied epistemology:**

  All intelligent activity presupposes knowledge. Knowledge is represented in a*knowledge base*, which consists of knowledge structures (typically symbolic) and programs. Brian C. Smith's *Knowledge Representation Hypothesis*forms the basis of this perspective :

  Any mechanically embodied intelligent process will be comprised of structural ingredients that

  - *we as external observers naturally take to represent a propositional account of the knowledge that the overall process exhibits, and}*
  - *independent of such external semantical attribution, play a formal but causal and essential role in engendering the behavior that manifests that knowledge.*

- **KR as a tell-ask module:**

  Not necessarily exclusive from the above, this is the lowest expectation out of a knowledge representation module in any AI system. Any KR system should provide at least two operations:

  - **TELL(K, *f*)** Given a knowledge base **K**, the fact*f*is added to it resulting in a new knowledge base, say **K'**.
  - **ASK(K, *f*)**The knowledge base **K** is being queried about a fact*f*. The answer, depending upon the KR paradigm (see below) used, may be *yes, no, unknown, yes with a confidence factor of **A**, ...etc.*

- **KR as *the* embodiment of AI systems:**

  This is the *connectionist view*. This approach takes the view that there are several (perhaps millions!) identical interconnected units that are collectively responsible for representing various concepts. A concept is represented in a distributed sense (as opposed to local) and is indicated by an evolving pattern of activity over a collection of units.

KR Paradigms

There are several paradigms that have emerged from these perspectives. The paradigms may be simply surveyed and/or if time permits, one or more may be introduced in some detail. Here are the key paradigms:

- **Procedural Knowledge:**Knowledge is encoded in functions/procedures. For example:

  function Person(*X*) **return** boolean **is**
  if (*X* = ``Socrates") **or**(*X* = ``Hillary") **then** return **true**
  else return **false**;

  function Mortal(*X*) **return** boolean **is**
  return person(*X*);

- **Networks:** A compromise between declarative and procedural schemes. Knowledge is represented in a labeled, directed graph whose nodes represent concepts and entities, while its arcs represent relationships between these entities and concepts.
- **Frames:** Much like a semantic network except each node represents prototypical concepts and/or situations. Each node has several property *slots* whose values may be specified or *inherited* by default.
- **Logic:** A way of declaratively representing knowledge. For example:

  person(Socrates).
  person(Hillary).
  forall X [person(X) ---> mortal(X)]

- **Decision Trees:** Concepts are organized in the form of a tree.
- **Statistical Knowledge:** The use of *certainty factors*, *Bayesian Networks*, *Dempster-Shafer Theory*,*Fuzzy Logics*, ..., etc.
- **Rules:** The use of *Production Systems* to encode condition-action rules (as in expert systems).
- **Parallel Distributed processing:** The use of connectionist models.
- **Subsumption Architectures:** Behaviors are encoded (represented) using layers of simple (numeric) finite-state machine elements.
- **Hybrid Schemes:** Any representation formalism employing a combination of KR schemes.

Propositional Logic

1. simple form of logic which is also known as Boolean logic.
2. A proposition has TRUTH values (0 and 1) which means it can have one of the two values i.e. True or False.
3. It is the most basic and widely used logic.
4. This logic is used for the development of powerful search algorithms including implementation methods.
5. Mathematically, logical operators combine propositions to make other propositions by following some specific rules.
6. Propositional logic is used in artificial intelligence for planning, problem-solving, intelligent control and most importantly for decision-making.
7. It is a useful tool for reasoning, but it has limitation because it cannot see inside prepositions and take advantage of relationships among them.

Properties

1.**Satisfiable:** A atomic propositional formula is satisfiable if there is an interpretation for which it is true.

2.**Tautology:** A propositional formula is valid or a tautology it is true for all possible interpretations.

3.**Contradiction:** A propositional formula is contradictory (unsatisfiable) if there is no interpretation for which it is true.

4.**Contingent:** A propositional logic can be contingent which means it can be neither a tautology nor a contradiction.

Standard Theorems Of Propositional Logic

Assuming p, q, and r represent the propositions which can be true or false and they are chosen arbitrarily. The list of standard theorems in propositional logic are as follows

1| p, q => p ∧ q
2| p, p → q => q (Modus Ponens)
3| ¬p, p ∨ q => q (law of disjunctive inference)
4| ¬q, p → q => ¬p (Modus Tollens)
5| p ∨ q, p → r, q → r => r
6| p → q, q → r => p → r (Chaining)
7| p, p → q, q → r => r (Modus Ponens & Chaining)
8| p ∨ (q ∧ ¬q) ⇔ p
9| p ∧ (q ∨ ¬q) ⇔ p
10| p → q ⇔ ¬p ∨ q
11| ¬(p → q) ⇔ p ∧ ¬q
12| p ↔ q ⇔ (p → q) ∧ (q → p) (Bidirectional elimination)
13| p ↔ q ⇔ (p ∧ q) ∨ (¬p → ¬q)
14| p → (q → r) ⇔ (p ∧ q) →r
15| p → q ⇔ ¬q → ¬p (Contraposition theorem)

Predicate Logic Or First-Order Logic

Predicate logic is a collection of formal systems which uses quantified variables over non-logical objects and allows the use of sentences which contain variables.

Difference Between Them

●Propositional logic deals with simple declarative propositions, while first-order logic additionally covers predicates and quantification.

●A proposition is a collection of declarative statements that has either a truth value “true” or a truth value “false”. While a predicate logic is an expression of one or more variables defined on some specific domain.