Introduction to Knowledge Fusion and Representation

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What is AI?

Using principled characterizations of interactions between agents and thier environments to guide explanation and design (Philip Agre 1995)

.... the study and construction of rational agents. (Stuart Russell and Peter Norvig 1995)

Acting rationally means acting in such a way as to achieve one's goals given one's beliefs.

An agent is just something that perceives and acts.

In this approach, AI is viewed as the study and construction of rational agents. (ibid.)

A Stronger Notion of Agency

A computer system that is either conceptualized or implemented using concepts that are more usually applied to humans. These concepts are mentalistic notions such as knowledge, belief, intention, obligation etc.

Knowledge

> Intelligent entities seem to anticipate their environments and the consequences of their actions. They act as if they know, in some sense, what the results would be. We can account for this anticipatory behavior by assuming that intelligent entities themselves possess knowledge of their environments. (Genesereth and Nilsson p2.)

Propositions: Statements about the world that are either true or false, right or wrong.

Knowledge-Based Systems

KR Hypothesis: (Brian Smith)

Any mechanically embodied intelligent process will be comprised of structural ingredients that a) We as external observers naturally take to represent a propositional account of the knowledge that the overall process exhibits, and b) independent of such external semantic attribution, play a formal but causal and essential role in engendering the behaviour that manifests that knowledge.

Implicit and Explicit Knowledge

KB is a set of sentences

explicit statement of sentences believed

$\mathbf{KB} \models \alpha$

- Explicit Knowledge: KB
- Implicit Knowledge: $\{\alpha | \mathbf{KB} \models \alpha\}$

Knowledge-Based System

Start with a KB representing what is explicitly known.

What to influence behavior based on what is implicit in the KB. This requires reasoning.

We want to calculate for any α, for a given KB whether or not

$$\mathbf{KB} \models \alpha$$

Knowledge Representation and Reasoning

How do we write down in some language descriptions of the world that correspond correctly to a state of the world?

How do we do so in such a way that computers can manipulate these representations and come to new conclusions?

Should this language be a logical language?

Cognitive Robotics

Most current work in robotics emphasizes basic-level tasks like sensory processing, path planning, manipulator design and control, reactive agents, artificial insects etc. In contrast, research in cognitive robotics is concerned with the theory and the implementation of robots that reason, act and perceive in changing, incompletely known, unpredictable environments.

Such robots must have higher level cognitive functions that involve reasoning, for example, about goals, actions, when to perceive and what to look for, the cognitive states of other agents, time, collaborative task execution, etc.

Cognitive Robotics (cont)

> In short, Cognitive Robotics is concerned with integrating reasoning, perception and action within a uniform theoretical and implementation framework.

From the description of the 1998 AAAI Fall Symposium on Cognitive Robotics

Data Integration

- Internet, Networks
- Databases, Web Pages, etc.
- Database Schemas
- Semantic Interoperability

Possible Solutions

- Standards
- XML as an exchange format
- Adapters/Mediators

Ontologies

- An Ontology is a formal conceptualization of the world.
- Description Logics
- Based on a subset of 1'st order logic
- Reasoning methods

Logic and Information Integration

- Formalization of the relation between concepts in a source view and a global view.
- A subset of 1'st order logic.
- Reasoning methods.

Semantic Web

- Current Web (based on HTML) provides material for presentation to people.
- Semantic Web aims to make that material interpretable by machines as well.
- XML, Ontologies, Description Logics, Agents