Cognitive agents

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Cognitive Agents

- A central aim of AI and cognitive science is the construction of intelligent agents, which we can define as software artifacts that exhibit intelligent behavior in complex domains over extended periods of time.

- Embedding agent in established cognitive architecture.

- CA's represent a new and growing paradigm for research in decision support, intelligent human-computer interfaces, etc.
CA's Definition

- A software entity which
  - Functions continuously and autonomously in a particular environment.
  - Able to carry out activities in a flexible and intelligent manner.
  - Responsive to changes in the environment.
  - Learn from experience.
  - Communicate and Co-operate with other agents.
  - Proactive; exhibit opportunistic, goal-oriented behavior and take the initiative when appropriate.
  - Perhaps move from place to place.
What CA's will do?

• CA's enable the construction of applications with
  - context sensitive behavior.
  - adaptive reasoning.
  - ability to monitor and respond to situation in real time.
  - based on an understanding of human cognitive architecture.
What to model?

- Human intelligence and human perspective of the world.
  - Environment (Knowledge/Set of Beliefs)
  - Desires (State of the environment the agent prefers)
  - Intentions (State of the environment the agent is trying to achieve)
- The beliefs, desires and intentions are related to the agents perceptions and actions.
CA's vs Reactive Agents

- Logic/Ontologies/Knowledge Reasoning
- High Cognitive cost
- Self-sufficiency*
- Episodic/Nonepisodic/planning actions

- Sensorial input
- Low Cost
- No Self-sufficiency
- Situated actions

* The capacity to manage one's own affairs, make one's own judgments, and provide for oneself: independence, self-determination, self-reliance. (Personal independence)

+ An ontology is an explicit specification of a conceptualization. The term is borrowed from philosophy, where an Ontology is a systematic account of Existence. For AI systems, what 'exists' is that which can be represented.
Design level observations

- The detailed problem solving actions of the agent can only be determined at run time.

- Since the behavior of the agents is not determined at design time, the behavior of the system as a whole can also only emerge at run time.
Belief-Desire-Intention Model

- Entities: Which have attributes.
- Objects: Entities that have capabilities.
- Agents: Objects with goals.
- Autonomous agents: Agents with motivations.
- Four stage design methodology:
  - Identify the relevant role in the application, on this basis develop agent class hierarchy.
Belief-Desire-Intention Model

- Identify the responsibilities associated with each role, the services required by and provided by the role, and then determine the goals associated with each service.

- For each goal determine the plans that may be used to achieve it, and the context conditions under which each plan is appropriate.

- Determine the belief structure of the system, i.e. information required for each plan and goal.
Intelligent tutoring system in the domain of radiology using cognitive agents
Objective

- Different types of expertise involved in ITS are knowledge on the subject, knowledge on the learners knowledge, pedagogical expertise etc.
- Requires more structured and sophisticated framework and needs to be adopted to the learner.
- It is necessary to learn more from the impacts of pedagogical actions.
- The objective is to show how the characteristics of a cognitive agent are appropriate for handling the pedagogical expertise, providing both a flexible structure and a way to improve learning.
Characteristics of CA's used

- Autonomous
- Interact with other CA's
- Supports 2 kinds of reactions:
  - Immediate response without reasoning
  - Controlled reactions that require planning, prediction and diagnosis.
- The CA's are instructable (2 types)
  - Classical instructions
  - Dynamic instructions (Execution time)
- CA's are having Self-improvement abilities. (adaptive)
- Learn by experience and discover new facts. (Machine learning)
Architecture of CA used

- Cognition layer
  - Which has machine learning expertise
- Knowledge layer
  - Perception (Recognizes typical situation for intervention)
  - Action (Actions to be activated to react in a given situation)
  - Control (Contains knowledge for answering the questions)
- A combination of control and action corresponds to reactive instructional planning.
Architecture of CA used

- Knowledge layer requires both procedural and declarative knowledge.
- Procedural knowledge is represented by a set of typical situations.
- Declarative knowledge ensures the various tasks of the agent. This knowledge is represented by a set of objects linked by binary relationships.
- The objects are similar to data structures.
Learning by disturbing strategy

- Elements involved
  - CA's (tutor and trouble maker)
  - goal of the strategy
  - conditions and applicability
  - results of its applications (post-conditions)
- Learner and trouble maker work under tutor.
- The control of the session is shared by CA's and session manager.
Learning by disturbing strategy

• CA's take all pedagogical decisions.
• Session mangers controls all that is directly related to the domain, such as the interface of the problem and the interpretation of the learners actions.
• As the learner interacts with the interface the CA's must be informed of his progress in order to adopt a behavior.
Learning by disturbing strategy

- Each time a learner interacts, the session manager composes and sends to the CA's a diagnosis message describing the action and the knowledge elements evidenced by it. This information is then processed by the CA's.

- For example, the tutor can congratulate the learner after a successful step in the problem resolution, give him a hint, etc.

- The troublemaker considers that the learner has a good knowledge level and calls the action task in order to try to mislead him.
Cognitive Agent Architecture (Cougaar)

- Cougaar is a Java-based architecture for the construction of large-scale distributed agent-based applications.

- It is a product of two consecutive, multi-year DARPA research programs into large-scale agent systems spanning eight years of effort.

- The first program conclusively demonstrated the feasibility of using advanced agent-based technology to conduct rapid, large scale, distributed logistics planning and replanning.

- The second program developed information technologies to enhance the survivability of these distributed agent-based systems operating in extremely chaotic environments.

- The resultant architecture, Cougaar, provides developers with a framework to implement large-scale distributed agent applications with minimal consideration for the underlying architecture and infrastructure. The Cougaar architecture uses the latest in agent-oriented component-based design and has a long list of powerful features.
Thank You