

COSC 6390A Knowledge Representation/Intelligent Agents
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Introduction to Intelligent/Autonomous Agents and their Applications

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What's an Agent?

“Upon logging in to your computer, you are presented with a list of email messages, sorted into order of importance by your personal digital assistant (PDA). You are then presented with a similar list of news articles; the assistant draws your attention to one particular article, which describes hitherto unknown work that is very close to your own. After an electronic discussion with a number of other PDAs, your PDA has already obtained a relevant technical report for you from an FTP site, in the anticipation that it will be of interest.” [Wooldridge & Jennings 95]

Core Attributes of Agents

Autonomy: act independently without (constant) human intervention.

Reactivity: perceive their environment and respond in timely manner to relevant changes.

Pro-activeness/goal-directedness: do not just react, but take the initiative and act to achieve their goals.

Social-ability: can interact/collaborate with other agents and users; often includes use of an agent communication language based on speech acts (inform, request, promise, etc.), e.g. KQML (Knowledge Query & Manipulation Language) or FIPA (Foundation for Intelligent Physical Agents) ACL.

Several Notions of Agent

On a continuum from light to heavy-duty:

- Mobile agents: processes that can move from host to host as they execute (Aglets, Agent Tcl, Telescript).
- Autonomous agents: long-lived processes that assist the user without necessarily using AI techniques; often required to have some of the core agent attributes.
- Processes in a complex system that are usefully described as having mental states such as beliefs, goals, intentions, etc.; agency as an abstraction mechanism.

Types of Work on Agents

Work on the internal (micro) aspects of agents can be divided in 3 areas:

- Processes that can communicate in an agent communication language based on speech acts (e.g. KQML, FIPA ACL); related to the above, since speech act communication requires agents to communicate as if they had mental states.
- Intelligent agents: processes that maintain symbolic representations of their beliefs, goals, etc., and chose how to act by performing reasoning.

In this course, focus on intelligent agents.

Agent theories: formal specifications of agent properties — what kind of mental states they have and how they are related to each other and to action; should support reasoning about agents.

Agent architectures : how to design and implement systems that have these properties — planning, decision making, belief update, etc., and their integration.

Agent languages: languages for programming agents and their implementation.

Also a lot of work on external (macro) aspects of agents (primarily in DAI): multi-agent system architectures, coordination protocols, agent communication languages, etc.

Applications of Agents

Traditional distributed AI applications in industry, e.g. air-traffic control such as the OASIS system [Kinny et al 96] and [Steeb et al 88], electricity distribution management such as Archon project [Jennings 95], etc.

Personal assistants of various kinds, e.g. meeting scheduling [Kautz et al 94, Maes 94, Mitchell et al 94], entertainment (book/movie) selection [Maes 94], etc.

Information gathering/filtering (typically on the Internet), e.g. Etzioni & Weld [94]'s Internet softbot, email handling & filtering such as Maxims system [Maes 94], news filtering such as Newt system [Maes 94], digital libraries [Durfee 97, Zuno 97], etc.

Intelligent interfaces and groupware applications, multimedia presentation, e.g. [Rich & Sidner 97].

Electronic commerce, e.g. shopping agents such as Jango, systems for supply chain integration, workflow management, customizable enterprise telecommunication systems, etc.

Robot control, e.g. mail delivery robots [Lespérance et al 94/99], museum guide robots [Burgard et al 98], etc.

Believable agents for entertainment and games e.g. [Hayes-Roth et al 95, Cassel et al 94].

Why the Interest in Agents?

Agents are viewed as a key technology for dealing with the new challenges faced by information infrastructure.

Under the push of electronic commerce and the Internet, more and more applications must operate in open systems, where there is a lot of information available from multiple sources, much of it unstructured.

Agent communication languages and protocols, match-maker and facilitator agents, could be the glue that allows these applications configure themselves to work together dynamically.

Ontology broker and interpreter agents could allow applications (databases) to understand each other even though they use different terminology.

Cognitive Robotics

Theory and implementation of agents that reason, act and perceive in a changing, incompletely known, unpredictable environment.

Reasoning about:

- Goals
- Actions
- When to perceive and what to look for
- The cognitive states of other agents.

Cognitive robotics is concerned with integrating reasoning, perception and action within a uniform theoretical and implementation framework.

Applications Developed

Have developed:

- logical model of agency that integrates reasoning, action, & perception
- Golog, a high-level agent programming language
- ConGolog, version of Golog with concurrent processes, etc.
- IndiGolog, version of ConGolog with incremental execution for implementing embedded agents;
- prototype implementations in Prolog.

Joint work with Levesque and Reiter at U. of Toronto, De Giacomo at U. of Rome, & others.

- Robot control: ConGolog and IndiGolog interfaced with navigation software running on various robots and used to program high-level controllers; tested in mail delivery applications; currently working on planning and operation in dynamic environments and multi-robot coordination.
- Formalisms and tools for agent-oriented software engineering: modeling of business processes (e.g. e-commerce) and telecommunication applications with multiple agents and mental states; use in requirements engineering; tools for simulation and verification.
- Intelligent software agents:
 - meeting scheduling tool
 - home banking tool
 - CAD assistant

References

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