Chapter 19: Intelligent Agents and Creativity

19.1 Opening Vignettes: Examples of Intelligent Agents

Vignette 1: Empowering Employees with Software Agents

- Nike and Signet Bank installed special software agents
- Employees access the human resources databases and
  - Select and Change Benefits
  - Make Charity Contributions

- **Electronic Workforce (from Edify Corp.)**
- **Delegates time-consuming and repetitive tasks of human resource (HR) employees to any employee**
- **Enables employees to enter, update and delete data; and interpret information**
- **Cuts error rate**
- **Enabling software is an *intelligent agent***

Vignette 2: Software Agents Cooperating to Provide the Best Travel Plans

19.2 Intelligent Agents (IA): An Overview

- **Intelligent Agent (IA): Computer program that helps a user with routine computer tasks**
- **New Technology**
- **Other Names**
  - **Software agents**
  - **Wizards**
  - **Knowbots**
  - **Softbots**
- **Agent: Employing someone to act on your behalf**

Several Definitions of Intelligent Agent

- "*Intelligent agents* are software entities that carry out some set of operations on behalf of a user or another program, with some degree of independence or autonomy and in so doing, employ some knowledge or representation of the user's goals or desires." ("The IBM Agent" [http://activist.gpl.ibm.com:81/WhitePaper/ptc2.htm])

- An *agent* is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors (Russell and Norvig [1995], p. 33)

- *Autonomous agents* are computational systems that inhabit some complex dynamic environment, sense and act autonomously in this environment and by doing so realize a set of goals or tasks for which they are designed (Maes [1995], p. 108)

More Definitions of Intelligent Agent

- **A persistent software entity dedicated to a specific purpose. "Persistent" distinguishes agents from subroutines; *agents* have *their own ideas* about how to accomplish tasks, e.g., their own agenda. "Special purpose" distinguishes them from entire multifunction applications; agents are typically much smaller" (Smith et al. [1994])**

- ***Intelligent agents* continuously perform three functions: perception of dynamic conditions in the environment; action to affect conditions in the environment; and reasoning to interpret perceptions, solve problems, draw inferences and determine actions (Hayes-Roth [1995])**

Possible Components of an Agent

- Owner
- Author
- Account
- Goal
- Subject Description
- Creation and Duration
- Background
- Intelligent System

19.3 Characteristics of Intelligent Agents

- **Autonomy**

  Agent takes initiative, exercises control over its actions
  - **Goal-oriented**
  - **Collaborative**
  - **Flexible**
  - **Self-starting**

- **Operates in the Background**
  - **Mobile agents**

- **Single Task**
  - **Communication**
  - **Automates Repetitive Tasks**
  - **Supports Conditional Processing**
  - **Learning**
  - ***Reactivity***
  - **Proactiveness**
  - **Temporal Continuity**
  - **Personality**
  - **Mobility**

19.4 Why Intelligent Agents?

Information Overload

- **Data Doubles Annually (in Large Enterprises [1998])**
  - **Can analyze only about 5%**
  - **Most Efforts: Discover patterns, not meaning, not what to do**
  - **Reduces decision making capabilities by 50%**
- **Much Caused by the Internet / Web**
  - **How to filter data?**
  - **How to identify relevant sources of data?**
- **Intelligent Agents Can Assist Searching**
- **Save Time: Agents Decide What is Relevant to**

Reasons for Intelligent Agent Technology Growth

- Decision Support
- Repetitive Office Activity
- Mundane Personal Activity
- Search and Retrieval
- Domain Experts

19.5 Agent Classification and Types

- **Taxonomic Tree to Classify Autonomous Agents (Figure 19.1)**
- **Relevant to Managerial Decision Making**
  - **Computational Agents**
  - **Software Agents**
  - **Task-specific Agents**

Intelligent Agent Classifications

- Control Structure
- Computational Environment
- Programming Language
- Application Type

Application Types

- **Organizational and Personal Agents**
- **Private Agents vs. Public Agents**
- **Software (Simple) Agents and Intelligent Agents**
- **Mobile Agents**
- **Classification by Characteristics**
  - **Agency**
  - **Intelligence**
  - **Mobility**

- **Agency: Degree of Autonomy and Authority Vested in the Agent**
  - **Key value of agents**
  - **More advanced agents can interact with other entities**

- **Intelligence: Degree of Reasoning and Learned Behavior**

- **Mobility: Degree to which agents themselves travel through the network**
  - **Static**
  - **Mobile Scripts**
  - **Mobile with State**
  - **Nonmobile Agents Defined in 2-D (Figure 19.4a)**
  - **Mobile Agents Defined in 3-D (Figure 19.4b)**

Classification by Intelligence Level and Power (Lee et al. [1997])

- **Level 0 (Lowest). Retrieve documents directly**
- **Level 1. Provide user-initiated searching facility for finding relevant Web pages**
- **Level 2. Maintain user's profiles. Monitor Internet information; notify users when relevant information is found**
- **Level 3. Have a learning and deductive component of user profiles to help a user**

Classification by Application Area

- Agents that assist in workflow and administrative management
- Agents that collaborate with other agents and individuals
- Agents that support electronic commerce
- Agents that support desktop applications
- Agents that assist in information access and management
- Agents that process mail and messages
- Agents that control and manage the network access
- Agents that manage systems and networks
- Agents that create user interfaces

Agent Classification

- **Internet Based**
- **Electronic Commerce**
- **Others**

19.6 Internet-based Software Agents

Software Robots or Softbots

Major Categories

- E-mail Agents (Figure 19.5)
- Web Browsing Assisting Agents
- Frequently Asked Questions (FAQ) Agents
- Intelligent Search (or Indexing) Agents
- Internet Softbot

- **Network Management and Monitoring**
  - **Patrol Application Management**
  - **Tabriz**
  - **WatchGuard**
  - **AlertView**
  - **InterAp**
  - **Mercury Center's Newshound**
  - **Infosage**

19.7 Electronic Commerce Agents

- Help users find information about products or services
- User provides information directly or indirectly
- Examples
  - Bargain Finder
  - Finding What Individuals Want: Firefly and Others
  - Good Stuff Cheap (GSC)
  - Other EC Agents
    - Book Worms Bargainbot
    - Eves
    - Resume Robot

19.8 Other Agents, Including Data Mining

- Representative Examples
- User Interface
- Intelligent Agents
  - Monitor the user's actions
  - Develop models of user abilities
  - Automatically help out

Operating Systems Agents

Wizards in Microsoft Windows NT Operating Systems

- **Add user accounts**
- **Group management**
- **Managing file and folder access**
- **Add printer**
- **Add/remove programs**
- **Network client administrator**
- **Licenses**
- **Install new modems**
- **Spreadsheet Agents: Makes software more friendly**

Workflow and Administrative Management Agents

- Ascertain and automate user needs or business processes
- Example - FlowMark
- Software Development
  - Many routine tasks can be done or supported by agents

Data Mining

- One of the most important capabilities of information technology
- Can sift through large amounts of information
- Challenge: intelligent agents to sift and sort
- Categories
  - Intelligent agents
  - Query-and-reporting tools
  - Multidimensional-analysis

Web Mining

Subsets (Etzioni [1996])

- Resource Discovery
- Information Extraction
- Generalization

NewsAlert

- **Monitors data by *personalized* rules**
- **Automatically delivers *alerts* to the user's desktop into personalized newspapers**
- **Organizes alerts by user specified subject areas**
- **Provides *smart tools* so users can investigate the context of an alert and communicate findings to others**

Key Components of *NewsAlert*:

- **Software Agents**
- **Alert Objects**
- **Newspaper Client**

Electronic Newspapers

- **Combine Features of a Paper Newspaper**
- **Familiar Format**

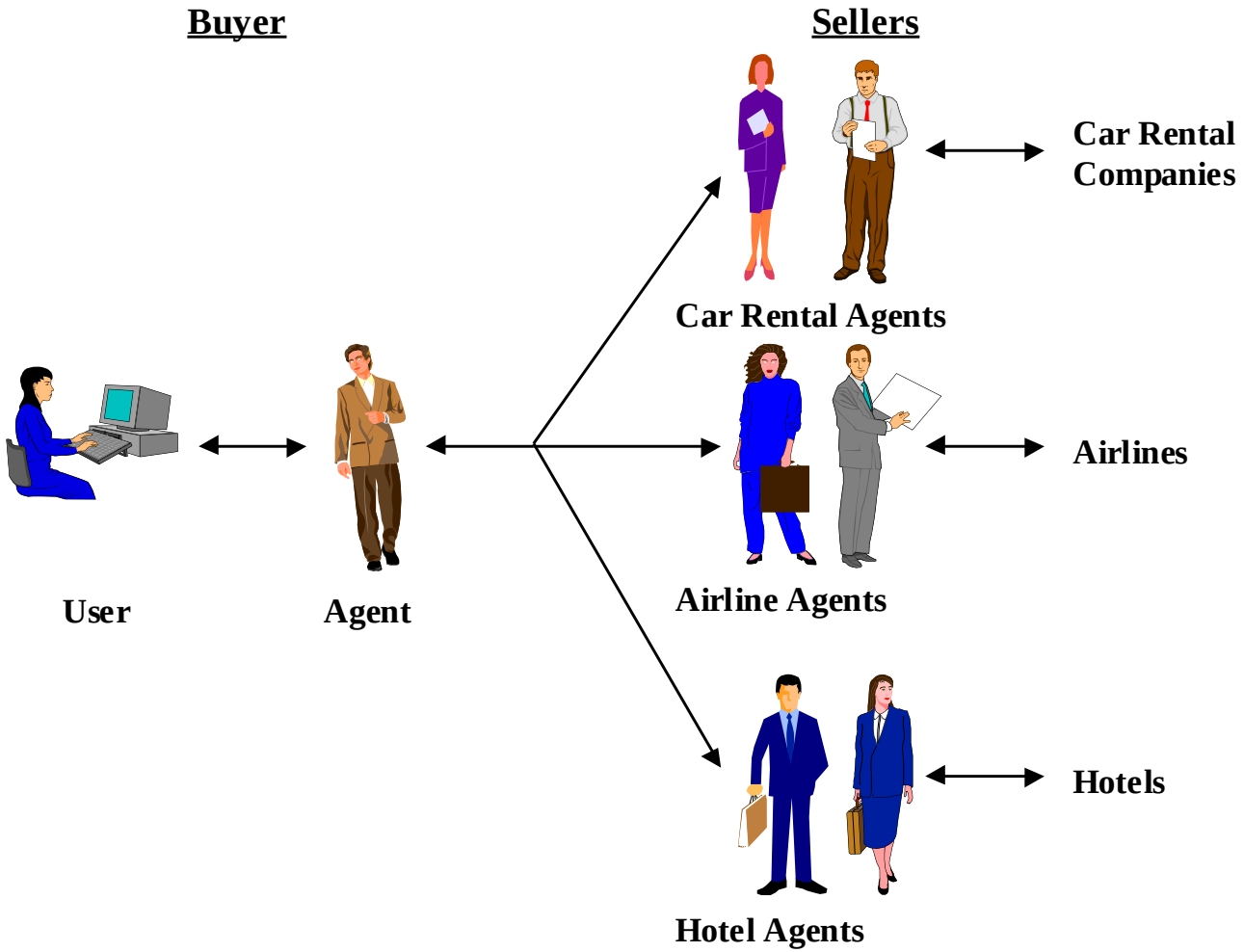
Collaboration by Agents

- ***Lotus Notes*: Comprehensive collaborative software**
- **Includes *Notes Agents:* automates many Notes tasks**
- **Agents operate in the *background* performing routine tasks**
- **Agents can be *created* by designers within an application**
- **Agents can either be *private* or *shared***
- **Collaboration: Natural area for agent-to-agent interaction and communication**

19.9 Multiple Agents and Distributed AI

- Software agents must *communicate* with each other
- Refine requests and queries through *evolving dialogue*
- Intelligent agents work together in multiple agent systems
- Agents can *communicate*, *cooperate* and/or *negotiate*
- Easy to build agents with small specialized knowledge
- But complex tasks require much knowledge
- Agents need to *share* their knowledge

Figure 19.8 A Multiagent System for Travel Arrangements



Routing in Telecommunication Networks

- **Agents control a telecommunications network**
- **Can enter into *agreements* with other computers that control other networks about routing packets more efficiently**
- **Agent in a *blackboard* architecture**

More Multiple Agents

- **Personal digital assistants (PDA)**
- **Shared (global) databases**
- **Agents (softbots) travel out on the Internet and collect information from shared databases**
- **Traffic control**
- **Coordination of vehicular traffic**
- **Air traffic control**
- **The University of Massachusetts CIG Searchbots**

- **Software agents make decisions based on *communication* and *agreements* with other agents**

- **Soon: Agents coordinating sellers and buyers**

Topics in Multiagent Systems

- Negotiation in Electronic Commerce
- Coordination
- The Nature of the Agents
- Learning Agents
- Cooperation and Collaboration

19.10 Software-supported Creativity

Computer programs that

- Exhibit *creative behavior*
- Facilitate human creativity

Creative Software Programs

- **Major characteristic of intelligent behavior is creativity**
- **Can computers be creative?**

Three Creativity Software Tools (Rasmus [1995])

1. **Copycat: Seeks analogies in patterns of letters**
   - **(Identifying patterns is the essence of intelligence)**

2. **Tabletop**
   - **Individual agents compete for correctness of fit**
   - **Copycat's internal architecture:**
     - **Cohesive parallelism**
     - **Converge upon an answer**
     - **From partial ones**
     - **While finding analogies.**

3. **AARON can draw real artwork**

But really need multiple agents to expand this

Computerized Support for Creativity and Idea Generation

- There are many semistructured and unstructured situations for which not all the alternative courses of action are known
- Idea generation is frequently necessary in DSS
- Idea generation is part of problem solving
- To generate good ideas, people need to be *creative*

- ***Past conventional wisdom*: An individual's creative ability came from personality traits**
- ***New studies indicate*: Individual creativity can be learned and improved**
- **Innovative companies recognize that to foster creativity, *create an idea-nurturing work environment***
- **New idea generation methods are under development**
- **Manual idea generation can be very successful**
- **But, may not be economically feasible nor possible**

Problems with Manual Idea Generation

1. Single decision maker
2. Poor (or no) facilitator
3. Not enough time for proper idea generation
4. Too expensive to conduct an idea generation session
5. Too sensitive a subject
6. Not enough participants, nonoptimal participant mix or not a positive climate for idea generation

Then: induce idea generation electronically

Idea Generation Software

- Designed to help stimulate a single user or a group with new ideas, options and choices
- An electronic brainstorming tool based on synergy (and/or association)
- The user does all the work
- Software encourages and pushes like a personal trainer
- Several software packages on the market

  (See Book's Web Site)

Idea Generation in GDSS

- **Allows participants to generate ideas simultaneously**
- **Recent GSS development: intelligent agent facilitator**

19.11 Managerial Issues

- Cost Justification
- Stand-alone agents perform complex tasks; but can be quite expensive (tremendous amount of R&D to create)
- Security (of Systems)
- Privacy
- Industrial Intelligence and Ethics
- Other Ethical Issues
- Agent Learning
- Agent Accuracy
- Heightened Expectations
- System Acceptance
- System Technology
- Agent Development Tool Kits (see Book's Web Site)
- Strategic Information Systems

Conclusions

- **Agents can simplify our use of computers**
- **Agents can provide friendly software assistance**
- **Agents promise to hide complexity**
- **Agents perform actions we do not do ourselves**
- **Agents could enhance human intelligence**
- **Agents provide support to Net users in handling the information overload problem**

But: Danger!

- Agents are unlike other technological advances
- Agents have some level of intelligence, some form of
  - Self-initiated and
  - Self-determined goals
- There is the potential for
  - Social mischief
  - Systems that run amok
  - Loss of privacy
  - Further alienation of society

Can Eliminate Such Problems

- Develop rules for well-behaving agents
- Determine the accuracy of information collected
- Respect restrictions of other servers
- Do only authorized work

Summary

- **Several definitions of Intelligent Agents (IA): Software entities that perform tasks with some degree of autonomy**
- **IA can save time and are consistent. They have varying levels of autonomy**
- **Major characteristics of IA: Autonomy, operating in background, communication capabilities and reactivity**
- **More autonomous agents must be able to learn and improve their actions**
- **The major purpose of IA is to deal with information overload However, agents can improve productivity, quality and speed**

- **Agents can be classified in several ways, depending on their mission**
- **Mobile agents can perform tasks in different locations. Other agents work in one place (e.g., a server, workstation).**
- **Agents can be classified into 3 major applications types: Internet, EC and others**
- **Multiagent systems can be used to execute more complex tasks than single agents, but they have not yet matured**
- **Intelligent agents play a major role in data mining, helping to finding appropriate data and knowledge quickly and answers queries**

Questions for the Opening Vignette

1. List the benefits that occurred at Signet Bank through intelligent agents.
2. List the benefits that occurred at Nike through intelligent agents.
3. How can the employees save time by working with intelligent agents? How would you feel about interacting with an intelligent agent instead of a human being? What if the cost of the service is 25% lower? What if the service cannot reasonably be offered otherwise?
4. How do you feel about making travel arrangements with a machine instead of with a travel agent?

Exercises

3. How are IA actually constructed? Investigate the literature and write a report.

4. What mundane tasks would you like an intelligent agent to perform for you? List them (you may want to include some tasks that people are handling for you), and describe how an IA could help. Compare your results to those of other members in the class.

Group Exercise

Contact Microsoft and/or their vendors. Find what IA Wizards do for the improved use of operating systems, spreadsheets and other software products. Prepare a report on recent developments.