CISC 434: Processes – IV

- Threads
- Virtualization
- Clients and Server Design Issues
- Code Migration
- Agents
Software Agents

- **What is an agent?**
  - No well-accepted definition
  - Another view of processes, but
    - More than a process
    - An autonomous process – can react and initiate changes in its environment by collaborating with users and other agents

- **What agents are not?**
  - A software component which is *not* autonomous and *does not* learn and cooperate
  - Most components in distributed computing applications
A High-Level Classification of Agents
## General Properties of Agents

<table>
<thead>
<tr>
<th>Property</th>
<th>Common to all agents?</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autonomous</td>
<td>Yes</td>
<td>Can act on its own</td>
</tr>
<tr>
<td>Reactive</td>
<td>Yes</td>
<td>Responds timely to changes in its environment</td>
</tr>
<tr>
<td>Proactive</td>
<td>Yes</td>
<td>Initiates actions that affects its environment</td>
</tr>
<tr>
<td>Communicative</td>
<td>Yes</td>
<td>Can exchange information with users and other agents</td>
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<tr>
<td>Continuous</td>
<td>No</td>
<td>Has a relatively long lifespan</td>
</tr>
<tr>
<td>Mobile</td>
<td>No</td>
<td>Can migrate from one site to another</td>
</tr>
<tr>
<td>Adaptive</td>
<td>No</td>
<td>Capable of learning</td>
</tr>
</tbody>
</table>
General Model of an Agent Platform

- **Management component**
  - Keeps track of the agents for the associated platform
  - Creates and deletes agents
  - Looks up the current endpoints of agents (naming service)

- **Directory service** – look up what other agents on the platform have to offer

- **Agent Communication Channel (ACC)** – takes care of reliable and ordered point to point communication between agent platforms
Types of Agents

- Collaborative Agents
- Interface Agents
- Mobile Agents
- Information Agents
- Reactive Agents
- Heterogeneous Agent Systems
- Hybrid Agents (one or more of the above)
- Smart Agents – not a reality, dream of agent researchers
Collaborative Agents

- Emphasize autonomy and cooperation with other agents to perform tasks for their owners
- May learn, but not typically a major emphasis of their operation
- Negotiate with other collaborative agents for mutually acceptable decisions – arranging a meeting
Collaborative Agents – contd.

Applications

- Problems that are risky or too large for a centralized single agent due to resource limitations
- To allow interconnection and interoperation of multiple existing legacy systems, e.g., expert systems, decision support systems, etc.
- Inherently distributed problems, e.g., distributed sensor networks, air-traffic control, health care provisioning
- To enhance modularity (reduces complexity), speed (parallelism), reliability (redundancy), flexibility (new tasks by modularity) and reusability at the knowledge level (resource sharing)
Interface Agents

- A personal assistant that collaborates with the user in the same work environment (collaborative agents collaborate with other agents)
- Assist an end user in the use of one or more applications
- An example interface agent system
Interface Agents – contd.

- Learning of Interface Agents – usually from the user
  - By observing and imitating the user
  - Through receiving positive/negative feedback from the user
  - By receiving explicit instructions from the user
  - By asking other agents for advice (learning from peers)
Interface Agents – contd.

**Benefits**

- Reduce the work for the end user and application developer
- Can adapt to its user’s preferences and habits
- Know-how among the different users in the community may be shared (learn from their peers)
Mobile Agents

- Roaming wide area networks (WANs) such as the WWW
- Interacting with foreign hosts
- Gather information or perform the task on behalf of its owner
- Tasks may range from a flight reservation to managing a telecommunications network
- Requires strong mobility
  - Mobility is neither a necessary nor a sufficient condition for agenthood
  - Mobile agents are agents because they are autonomous and they cooperate
Mobile Agents – contd.

Benefits

- Reduced communication costs
- Limited local resources
- Simpler to coordinate a number of remote independent requests
- Asynchronous computing – ask your mobile agents to do a task independently and you can do something else
- Flexibility
  - new services can come and go dynamically
  - more flexible (dynamic) distributed computing architecture
Information Agents

- Manage information from many distributed sources
  - ordering, filtering, manipulating, and so on
  - Static or mobile, non cooperative or social, may or may not learn
- Stationary information agent – typically operate on incoming data streams – e.g., an email agent may be capable of filtering unwanted emails from its owner’s mail box
- Mobile information agent – generally roam the network on behalf of their owner to collect required information
Reactive Agents

- Act/respond in a *stimulus-response* manner to the present state of the environment
- Important application - games or entertainment industry
- Benefits
  - More robust and fault tolerant than other agent-based systems
  - Flexible, fast, and adaptable compared to the classical AI systems
Hybrid Agents

- A combination of two or more agent philosophies within a singular agent
  - Include a mobile philosophy, an interface agent philosophy, collaborative agent philosophy, etc.
- Challenges – similar to those identified for reactive agents
  - Most hybrid agents are intended to be very application-specific
  - Hybridism is usually incorporated in an ad hoc manner
Heterogeneous Agent Systems

- Unlike hybrid systems
  - It is an integration of at least two or more agents from different agent classes
  - The system may also contain one or more hybrid agents
  - Can interoperate in cooperative heterogeneous set-ups

- Benefits w.r.t. legacy software
  - Used to re-engineer legacy software to interoperate with other systems
Some Issues with Agents

- What is an appropriate agent communication language? – ACL (Agent Communication Language)?
- Should maintain user’s privacy when acting on a user’s behalf?
- When responsibility is delegated to software agent(s), authority is transferred too?
- If a agent offers some wrong advice to other peer agents who is liable legally?
- Safety – the agent should not violate the safety of the environment
- Is the agent itself secure?
Summary

- Types and general properties
  - Collaborative Agents
  - Mobile Agents
  - Interface Agents
  - Information Agents
  - Reactive Agents
  - Heterogeneous Agent Systems
  - Hybrid Agents

- Lecture source
  - Software Agents: An Overview
    http://www.sce.carleton.ca/netmanage/docs/AgentsOverview/ao.html