Lecture 12: Internet Agents

CS178: Programming Parallel and Distributed Systems

March 7, 2001
Steven P. Reiss

I. Overview

A. So far we have talked about current web architectures

1. **Classic client-server systems**
2. **Except with a web browser for display**
3. **And a web server as middleware**

B. Today I want to look at the future (possibly)

II. Internet Agents

A. For homework you were supposed to come up with an example internet agent

1. **Can be existing or something you would like to see**
2. **Some idea (vague) of how it might work**

B. Lets go over those now

III. What is an Internet or Web Agent

A. Basic idea

1. **An agent is an active, persistent software component that can perceive, reason, act, and communicate.**
2. **Active**
   a) An agent is not a sink, but a running piece of software
3. **Persistent**
   a) Exists for a while, possibly a long while
4. **Perceive**
   a) Get information from the outside world
   b) This means interacting with the web and other agents
5. **Reason**

a) The agent needs to process this information in a meaningful way
b) This means merging information from multiple sources
c) This means deciding what to do with the information

6. Act

a) The agent needs to do something other than gather info
b) This can be sending out commands or other information

7. Communicate

a) All this requires communication
b) With the user, with the web, with web services, with other agents

B. Properties that characterize different agents

1. Lifespan : transient to long-lived
2. Level of cognition : reactive to deliberative
3. Construction : declarative to procedural
4. Mobility : stationary to itinerant
5. Adaptability : fixed to teachable to autodidactic
6. Modeling : of environment, themselves, other agents
7. Locality : local to remote
8. Social autonomy : independent to controlled
9. Sociability : autistic, aware, reponsible, team player
10. Friendliness : cooperation to competitive to antagonistic
11. Interactions

a) Logistics : direct or via facilitators, mediators or nonagents
b) Style/Quality/Nature : with agents/world/both
c) Semantic Level : declarative or procedural communications

C. Agent Systems

1. Often agents work together in multiagent systems

a) Agents take advantage of other agents
b) Architectures are designed to support multiple agents

c) Agent systems have their own properties

2. **Uniqueness : homogenous to heterogenous**
3. **Granularity : fine-grained to coarse-grained**
4. **Control structure : hierarchy to democracy**
5. **Interface autonomy**
   a) Communication : specific vocubulary, language, protocol
   b) Intellect : specify goals, beliefs, ontologies
   c) Skills : specify procedures, behaviors
6. **Execution autonomy : independent to controlled**
7. **Autonomy**
   a) How freely can the agent choose its actions and what it does
   b) How much does this depend on other actions
   c) Does it extend to the internals or only the interface
   d) Does it extend to the design

D. Intelligent Agents

1. **What do we mean by intelligence**
   a) Mimicing human behavior
   b) Following common sense
   c) Rationality
2. **Rationality**
   a) There is a concrete performance measure for success
   b) At each point in time the agent tries to maximize this
      (1) Given what it has perceived so far
      (2) Given what it knows about the environment
      (3) Given the set of actions that it can perform
3. **This can be done in various ways**
   a) Hard-coded planning, either directly or using rules or some other similar framework
   b) Using a learning algorithm
      (1) Neural networks
      (2) Statistical learning, Reinforcement learning

IV. Agents and Internet Programming

A. Possible applications

1. Information-rich environments

a) Gathering information

(1) Resource discovery -- finding information sources

(2) Database querying -- getting information from databases and structured sources

(3) Information retrieval -- getting information from unstructures or semi-structured sources

(4) Stream retreval -- getting information from a stream

b) Information assessment

(1) Filtering -- determining what is & isn't relevant

(2) Fusion -- merging results in a meaningful manner

c) Acting on that information

(1) Buying or selling stock

(2) Recommending books or movies

(3) Alerting users to interesting web sites

(4) Providing relevant news alerts

(5) Showing where to find something the cheapest

2. Personal assistants

a) Getting complex tasks done

b) Tasks might require

(1) Information gathering & assessment

(2) Multiple, dependent actions

(3) Proper ordering and timing of those actions

c) Example -- trip planner

3. Auctions

a) Agents can be buyers of sellers

b) Clear objective functions

c) Several different strategies that can be used for negociation

4. Others (from homework)?

B. Interaction Models

1. Agents need to get information from the web

a) Web pages, components, other agents, databases, ...

b) HTTP provides a means of accessing the information

(1) Common protocol

(2) But this is not enough

c) Problems

(1) Need to find the sources

(2) Need to interpret the data

2. Finding sources

a) Automated discovery of web pages and services

b) Search engines do this by spidering

(1) Use search engines as a proxy

c) Other protocols are coming on line -- JINI

(1) JINI -- java based interface discovery mechanism

(2) Servers publish the interfaces they support

(3) Clients can find all or some servers that support a desired interface

d) WSDL (web service definition language)

(1) Web services define their functionality

(2) The definition files can be accessed and interpreted

(3) Repositories of service definition files

e) JAX -- java and xml services

(1) Allow definition of XML-based services

(2) With local (not network-wide) lookup of a service

3. Interpreting the data

a) A word means what I say it means

(1) There is no agreement on the web

(2) Even fixed things are variables (costs may include shipping, taxes, etc.)\

b) XML provides a basis for interpreting documents

(1) Tags can be inserted to annotate items (dates, costs)

(2) Structured documents provide real information w/o the need for natural language understanding

(3) But the result can still be ambiguous

c) XML standards

(1) These are slowly emerging in some areas

(2) They basically provide a semantics for XML in that area

(3) Long and drawn out political process however

d) RDF -- resource definition framework

(1) Describes resources -- anything accessible by a URL

(2) Provides properties associated with the resource

(3) Statements -- resource + property + value

(4) Values are XML structures w/ schemas

(5) Names and meanings are still subjective

e) Ontology -- a way of making sense of all this

(1) Provide ways of mapping words to meanings

(2) Provide ways of understanding what things are

(3) Several efforts aimed at developing a web ontology -- darpa, w3c

C. Execution Models

1. How would you implement a shopping agent

a) Discovery of store sites on the web

b) Finding the product (specific/general)

c) Finding prices, warranties, total costs, delivery dates, ...

d) Negociating prices -- with sites, with user

e) Making purchase

2. How would you implement a stock market agent

a) Finding information about companies (which/how)

b) Interpreting that information (short term/long term)

c) Tracking prices and price models

d) Buying and selling

e) Controlling the agent

V. Next time

A. In-class closed book midterm

B. Covering

1. Multithreaded programming
2. Synchronization techniques
3. Distributed programming
4. Internet programming

C. Form

1. Short answer -- should require understanding, not memorization
2. A little program design (pseudo code)