Challenges for Mobile Agents

Munindar P. Singh
singh@ncsu.edu
www.csc.ncsu.edu/faculty/mpsingh
Agents vs. Processes

Trend to relabel all processes as agents!

- Nothing is gained by changing the terminology if the meaning is unchanged

- The “meaning” should be in terms of additional abstractions attached with agents
  - specifically, abstractions to do with sociability and interactions with other agents are crucial
Agents

• An agent is an active, autonomous computational entity that
  – has a persistent identity
  – can perceive, reason about, and initiate activities in its environment
  – may be intelligent or adaptive
  – is sociable
  – can communicate (with other agents)
Multiagent Systems

- Distributed systems of agents that interact in ways that are
  - purposeful
  - potentially cooperative
  - usually communicative
  - knowledge-level
  - social

*Say no to autistic agents!*
Mobile Agents

- Computations whose locus of execution can move
- Potentially useful
  - when a large amount of data must be processed and the remote site does not have the procedures to perform the processing
  - to initiate and maintain long-lived sessions over intermittent communications
  - when the functionality of remote sites (aka servers) must be extended on the fly
Procedural vs. Declarative

Classical distinction between what and how

• Procedural approaches offer
  – efficiency of implementation
  – quicker start to hack a solution

• Declarative approaches offer
  – flexibility
  – modularity: incremental change
  – inspectability and learnability

• Long-term trend in CS toward declarative approaches: Lex, YACC, SQL
Shades of Autonomy

- Social
- Interface
- Execution
- Design

Mobility violates design autonomy, and makes it harder to guarantee social and execution autonomy.
Importance of Autonomy

• Local information structures may change
• Models of local processing need to be known, e.g., whether transactional and if so what kind
• How is this knowledge and changes to it propagated?
  – Propagating details of the “server” is no easier than propagating extensions
• Autonomy reduces the need for propagation
Mobility vs. Communication

- An alternative paradigm is based on placing stationary agents on different sites and letting them communicate
  - the agents communicate what, not how
  - they autonomously decide what operations to perform and what data to access for others
  - they exploit their knowledge of local information models to perform appropriate and efficient queries
  - any efficiency improvements made once apply to all
Communicating the Extensions

- An advantage of mobility is that the mobile agent can include whatever functionality it needs, though only if permitted to execute it!
- Consider a communication primitive
  - `install(func_name, vers, arg_types, code)`
  - the code will usually be quite high-level
  - The recipient can autonomously decide based on
    - identity and role of the requester
    - its attitude toward the requester
Mobile Agents Revisited

Mobile agents encapsulate

- procedural mode of operation
  - details of local information models
  - details of local interpreter
  - details of local processing semantics
  - deemphasize social and communicative aspects

- lose opportunities for efficiency and reuse
Challenges

Traditional

- Extensibility of programming languages and their interpreters
- Security of the sender and receiver
- Resource management
  - control the lifetimes of agents
  - prevent deadlock and livelock
  - prevent flooding of communication or storage resources
Challenges

Less common, but important for building complex systems involving agents:

- Incorporating models of
  - static information
  - dynamic processing
  - communication
  - coordination requirements
  - social abstractions

Doing so will blur the distinction between mobile and conventional agent implementation techniques.
Conclusions

Mobility

- is primarily a question of implementational infrastructure, but distracts from a number of high-level issues
- doesn’t enable any processing beyond conventional agents
- packages together a number of disparate features, which might be best treated independently
  - complicates design and maintenance of distributed systems
  - violates autonomy requirements
  - risks violating security in various ways

*Mobility … the goto statement of agent technology!*
To Probe Further

- Readings in Agents (Huhns & Singh, eds.), Morgan Kaufmann, 1997
- IEEE Internet Computing (bimonthly magazine)
- DAI-list-Request@ece.sc.edu
- International Journal of Cooperative Information Systems
- International Conference on Multiagent Systems (ICMAS)
- International Workshop on Agent Theories, Architectures, and Languages (ATAL)
- IFCIS Conference on Cooperative Information Systems (CoopIS)