

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)