Dramatic advances in the Internet and the computer industry have created many new opportunities for business. Electronic commerce has let many professions find their cyber-equivalent. Furthermore, the Internet can greatly facilitate access to potential markets in, for example, retail, finance, media, health, or manufacturing. Unfortunately, this expansion carries with it many associated problems. Security and privacy issues quickly come to mind, but information overflow, connectivity, reliability, and performance also require consideration.

The word agent’s origin is deeply rooted: drawing from the Greek agein, which means to drive or lead; from medieval Latin agere, with a similar meaning; and from Old Norse, aka, which implies travel in a vehicle. Merriam Webster defines agent as

- one capable of producing an effect;
- one that acts or exerts power;
- one that is authorized to act for or in the place of another as a representative, emissary, or a government official; and
- a business representative.

In the agent community, experts define agents as

- entities that can communicate in an agent communication language (Michael Genesereth),
- computer systems in a complex environment that realize a set of tasks and goals they were designed for (Pattie Maes), and
- systems capable of autonomous purposeful action in the real world (Jose Brustoloni).

Standards bodies define agents as computer programs acting autonomously on behalf of a person or organization (OMG MASIF, etc.).

For more information, see the articles in this issue.
www.omg.org) and as computational processes implementing an application’s autonomous communicating functionality (FIPA, www.fipa.org).

These definitions reflect important types of agents, such as autonomous, adaptive, reactive, mobile, cooperative, interactive, and delegated. These various agents can act for and in place of humans.

Agents still cannot develop strategies, contemplate new directions, or react to subtle and nonstraightforward reasoning, but many agent technologists would argue that these features will be forthcoming.

**Agent criticism**

Despite agent technology’s successful deployment, this area still draws criticism that agents are extensions of AI work; failed to gain popularity; will not enhance the Internet and other networks; can cause excessive Internet resource usage; are overhyped; and have no beneficial or sustaining power.

Indeed, many agent issues exist, including

- hype—untruths and unrealistic expectations;
- security—safeguards required for your and others’ agents;
- privacy—sharing versus hiding of sensitive information;
- law—responsibility for agent errors;
- intelligence—how much control to delegate to an agent; and
- social—whether agents should correct owner’s bad habits.

Agent criticism particularly targets mobile agents, which are still considered solutions in search of a problem. Such complex solutions are typically interesting to research, and mobile agents have seduced many (including me). Mobility offers many potential benefits, but none critical to solving problems in practice. Some useful side effects of the growing interest in mobility are the extensive work on security and transaction processing, and some (but few) performance studies.

Agents show promise—as they currently function and as they will in the future. To realize this promise, agent technology needs to lose the hype and to prove itself in the commercial world.

**In this issue**

This special issue of *IEEE Concurrency* features the five best papers presented at the First IEEE Symposium on Agent Systems and Applications and the Third Workshop on Mobile Agents (ASA/MA ’99, www.genmagic.com/asa). ASA/MA’99 aimed to merge different agent communities—particularly mobile agents, intelligent agents, and multiagent systems. This goal produced a diverse group of papers.

In the article, “Hive: Distributed Agents for Networking Things,” Nelson Minar, Matthew Gray, Oliver Roup, Raffi Krikorian, and Pattie Maes investigate a distributed systems environment from the agent perspective. They use agents to better integrate network and other resources ubiquitously. They address agents from the perspective of wearable computing, ad hoc connectivity, and decentralization. They provide a critical view of the benefits of mobility in current and future environments.

Liz Kendall, in her article “Role Modeling for Agent System Analysis, Design, and Implementation,” applies the role concept to agent system analysis and design. She discusses role model implementations based on role object patterns and on aspect-oriented programming (AOP). In this environment, roles are relevant as concepts, analysis models, and design templates, and for documenting interaction patterns. Roles support conceptual models of how agents can be used. AOP is concerned with aspect overlaps of roles and role aspect composition, such as merging, overriding, and adding. It is essential for defining policies, strategies, and optimizations.

“Nomadic Pict: Language and Infrastructure Design for Mobile Agents,” by Pawel Wojciechowski and Peter Sewell, introduces a new language and infrastructure design for mobile agents. A main feature is location-independent communication among mobile entities. Nomadic Pict supports both high- and low-level abstractions based on process calculi. The authors present an implementation, based on Objective Caml, a dialect of ML. This article was selected as the best in ASA/MA’99.

In “The Effects of a Mobile Agent on File Service,” Tammo Spalink, John Hartman, and Garth Gibson investigate how mobile agents affect file service. Using trace-driven simulation, they address the relationship of mobile agents and the memory size and speed of file servers. The authors conclude that mobile agents should not visit overloaded servers, and that memory size does not play a significant role, owing to caching effect. These conclusions have direct relevance for the deployment and use of future mobile agents.

“Optimizing the Dissemination of Mobile Agents for Distributed Information Filtering,” by Wolfgang Theilmann and Kurt Rothermel, thoroughly analyzes the often taken for granted benefits of mobile agents. The authors use a trace-driven simulation to validate the benefits of up to 90% performance improvement of mobile agents over static agents. They achieve this in a testbed environment of Internet-based distributed servers visited by mobile “filter” agents.

For more information on this issue, see the sidebar on p. 69.

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