

The Agents Are All Busy Doing Stuff!

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Jim Hendler asks, "Where have all the agents gone?" (see A Letter from the Editor in the May/June 2007 issue). The short answer to the question is: The agents are all busy doing stuff! You're just not looking for them in the right places!

It seems that the question arises because most of us, as consumers, can only readily imagine business-to-consumer applications of new technologies. Yet, the most compelling applications of agent technologies were always, are now, and will always be in business-to-business (B2B) domains, out-of-sight of most consumers.

The latest weekly statistics from the New York Stock Exchange, for instance, state that in the week of 9–13 April 2007, some 31.7 percent of shares traded on the NYSE by volume were program-traded. Most of these will be trades undertaken by software agents. In some weeks, this proportion has been much higher: for example, it reached 71 percent of shares traded in the week of 12–16 September 2005. In fact, according to a 19 April 2007 press release, the NYSE's definition of program trading might undercount the actual proportion of stock transactions due to software agents (see www.nyse.com/press/1177066052223.html).

As another B2B example from finance, in January this year, Barclays Capital launched an automated, foreign-exchange currency fund, a software program which buys and sells forex automatically. According to the 8 January 2007 *Financial Times*, the fund joins existing automated hedge funds from Merrill Lynch and Goldman Sachs. Such efforts will only proliferate now that the US Securities and Exchange Commission has begun to annotate EDGAR, its database of company information (see www.sec.gov/news/press/2006/2006-158.htm).

More generally, it's inappropriate to think of agents as a solution to some problem or as potential "killer applications." Rather, agent technologies provide a means of conceptualizing an application domain or a software engineering task as comprising self-interested and autonomous entities. Then, with this conceptualization, agent technologies provide a means for specifying, designing, engineering,

and managing the resulting software systems. Hence, we have many agent technologies, not one, and to ask "Where are all the agents?" is to misunderstand these technologies' nature and scope.

Asking this question also risks misunderstanding the pervasiveness of these technologies' use and deployment. Many companies founded their business on agent technologies: what they sell is not just a conceptualization but a conceptualization allied to specific agent-related technologies. So Eurobios, for example, applies optimization technologies that can be used in the context of the conceptualization of agents. Agentis Software offers goal-directed technologies based on the BDI (belief-desire-intention) model, as does the Agent Oriented Software Group. Similarly, Lost Wax, Magenta Technology, and Whitestein Technologies (and Living Systems) have technology platforms or products that use the conceptualization (see the "Related Resources" sidebar). In 2004 and 2005, AgentLink (www.agentlink.org), a European Commission-funded network to support research and development of agent-based computing, collated detailed case studies of some of the applications of these agent technologies. Collected as part of AgentLink's efforts to engage industry and to support the transfer of agent technologies from academia to industry, these case studies provide a snapshot of the state of deployment and commercialization of agent technologies.

It's true that offline simulation and optimization have been the primary application domains of agent technologies. Many immediate commercial opportunities exist here because infrastructure has only recently progressed to allow deployment of agents in online production systems. We're at the point where we can now build open and dynamic systems, which underpin nearly all views of future computing, but we haven't yet done so to any great extent (see the AgentLink document charting agent technology development, www.agentlink.org/roadmap/index.html). Once we do, the prevailing model of computing changes—even current large-scale distributed systems are not open and dynamic in the manner envisioned—so it makes sense to think and work in terms of the agent conceptualization and the associated technologies that go with it.

A comparison with object-oriented technologies is instructive. Proponents of OO technologies could not always have given comfortable answers to the question, “Where are all the objects?” especially if this question had been asked in, say, 1982. Yet, that was a full two decades after the invention of the OO concept in 1962, which is approximately the length of time that agent computing concepts have now been in circulation. In 1982, of course, Java was still 13 years away from public release. We’re not claiming here that agent technologies will have as great an impact on computing as have object technologies, and there are many reasons why they are unlikely to do so (see the AgentLink Roadmap, www.agentlink.org/roadmap/index.html, for a more detailed analysis). Nevertheless, we see agent technologies currently being used, both experimentally and commercially. This is the case despite the lack of a foundational “prediscipline” that, for instance, the Semantic Web enjoyed (in extensive prior research on knowledge representation and logic) before it coalesced into its current form.

Once dynamic and open systems become the norm, they’ll need to adopt agent technologies as fundamental. The conceptualization of agents (and possibly the technologies) might not then be distinct domains of study but could become a part of the accepted view of what constitutes computing.

Related Resources

Agent Oriented Software Group: www.agent-software.com

Agentis Software: www.agentissoftware.com

Eurobios: www.eurobios.com

Lost Wax: www.lostwax.com

Magenta Technology: www.magenta-technology.com

Whitestein (and Living Systems): www.whitestein.com

- R.A. Belecheanu et al., “Commercial Applications of Agents: Lessons, Experiences and Challenges,” *Proc. 5th Int’l Conf. Autonomous Agents and Multiagent Systems* (AAMAS 06), ACM Press, 2006, pp. 1549–1555.
- O.-J. Dahl, “The Roots of Object Orientation: The Simula Language,” *Software Pioneers: Contributions to Software Engineering*, M. Broy and E. Denert, eds., Springer, 2002, pp. 78–90.
- S. Munroe et al., “Crossing the Agent Technology Chasm: Experiences and Challenges in Commercial Applications of Agents,” *Knowledge Eng. Rev.*, vol. 21, no. 4, 2006, pp. 345–392.

Indeed, as with object orientation, which we usually don’t consider to be a specific technology, it’s likely that agents will simply be the normal way of conceiving and engineering computer systems. Such a development will lead to increased opportunities for agent technology application and deployment because in a world of pervasive distributed computing, we’ll require methods and systems for negotiation, auctions, trust and reputation, coalitions, and so on. As computer scientist Christos Papadimitriou noted at his presentation at the 2001 Annual Symposium on the Theory of Computing about software engineering design, “All design problems are now mecha-

nism design problems” (see, <http://doi.acm.org/10.1145/380752.380883>). Will it be an indication of failure or of success when no one talks of agents anymore because agent approaches are so pervasive in the next generation of computing? □

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