

FINAL TECHNICAL REPORT

GRANT #: N00014-00-1-0769

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INSTITUTION: The University of Memphis

GRANT TITLE: A Development Period for Software Agents

AWARD PERIOD: 6/1/00 - 9/30/01

OBJECTIVE: This project is in the context of the larger IDA (Intelligent Distribution Agents) project. Here we intend to plan and design a development period for such agents, and code parts of the first stage (see below). During this period, such an agent would systematically learn needed domain (community) detailer knowledge from a human detailer. This would be accomplished in stages. At first the agent would watch the human detailer (imitative learning) asking questions about concepts not understood. Later the agent would work under the supervision of the human detailer on cases designed for training. Finally the agent would work unsupervised. Our design would include descriptions of the mechanisms by means of which such developmental learning could take place. These would include conceptual, behavioral and imitative learning mechanisms for our “conscious” software agents.

APPROACH: There are five of us working actively on the project, including myself, one full-time researcher/developer supported by this grant and other IDA grants and contracts, and one research assistant supported by this grant.. The other two are doctoral students working on their dissertations but not supported by this grant. The mechanism we’re designing will make use of the existing IDA architecture and mechanisms, but will require the addition of an episodic memory. We have recently acquired existing software libraries to facilitate it’s implementation. The code is now being studied to determine it s usefulness. IDA perception and language generation modules are being enhanced so as to be able to cope with the incoming and outgoing messages that will enable the learning.

ACCOMPLISHMENTS Detailed planning made significant progress in all three categories, conceptual, behavioral and imitative learning. High-level plans are essentially in place for the conceptual and behavioral learning modules having capitalized on earlier efforts. Work on modifying the perceptual apparatus to accommodate conceptual learning is now complete. The modifications to the behavior net mechanism to allow for behavioral learning are complete. The behavior net module is up and running. A further modification of this module to allow specifications of behaviors and behavior streams using XML descriptions has been accomplished.

One way for IDA to watch a detailer at work is simply to read copies of his or her incoming and outgoing email from members of the community. IDA reads the detailer’s job offers to the member, decides what jobs she would have offered, and question the detailer about any difference.

This outgoing email includes several message types. IDA’s perceptual module has been modified so as to handle the major such message type, the original offer of jobs to a member. Having understood such a message, code has been added to IDA so that she can decide what jobs she would have offered. Additional new code compares the detailer’s job offers to those IDA would have made and identifies differences. With the help of a detailer, we’ve been working successfully on identifying such differences. The following table lists a number of possible differences. Behavior streams and language generating codelets to allow IDA to query the detailer about the differences have been designed and coded and are now running

Detailer offered this job because	Detailer did not offered this job because
1. This job is close to sailor’s hometown.	1. The job requires a different rating

2. This billet is a special program and we need to fill it.	2. Moving costs are too high
3. There are more jobs vacancies in the east coast then the west coast.	3. It's a shore job and sailor needs to complete 4 years at sea.
4. There are no shore duty billets and the PRD window is getting closer to 9 months. So I offered him back-to-back sea duty.	4. Sailor has been on shore for a long time and so has a lower priority than others.
5. This billet will boost the sailor's carrier opportunities.	

Also the perceptual module has been enhanced so as to understand a detailer's reply. In particular, IDA 's perceptual module has been modified to accommodate these differences. The ongoing research on this imitative learning is now concentrated on how to tweak IDA's constraint satisfaction module to correct for errors pointed out by the detailer.

CONCLUSIONS: After this more detailed planning and some coding, all three types of learning, perceptual, behavioral, and imitative, seem even more plausible earlier and even more implementable. We conclude that such a development period for a software agent such as IDA is a reasonable goal. It should provide both theoretical insights and certainly would be highly cost effective as compared to traditional knowledge engineering.

SIGNIFICANCE: What we've designed here is, to my knowledge, completely new to the field of software agents. No such agents to date learn new concepts and new behaviors via natural language dialog with humans. Some software agents do go through a development period during which they imitate their users. None go through the kind of phased development envisioned here. On the science side, this research explores the capabilities of software agents to learn in this manner via mechanisms modeling human learning of this sort. Testable hypotheses about human learning can result. On the practical side, this sort of learning and development promises to relieve the prohibitively expensive knowledge engineering that would otherwise be required in implementing distribution agents to serve different communities and commands.

AWARD INFORMATION: Named Dunavant University Professor.

REFEREED PUBLICATIONS (for total award period):

We have the following earlier publications devoted to the subjects of this project. They describe earlier plans and designs.

Negatu, A., and S. Franklin 1999, Learning for Adaptive Software Agents. Intelligent Systems: ISCA 5th International Conference; International Society for Computers and Their Applications – ISCA. Denver, Colorado; June 1999.

Ramamurthy, U., S. Franklin, and A. Negatu. 1998. Learning Concepts in Software Agents. In *From animals to animats 5: Proceedings of The Fifth International Conference on Simulation of Adaptive Behavior*, ed. R. Pfeifer, B. Blumberg, J.-A. Meyer, and S. W. Wilson. Cambridge, Mass: MIT Press.

In addition, a new paper describing the neural schema mechanism has been written describing the system and experimental results from it. It has been submitted for publication.:

BOOK CHAPTERS, SUBMISSIONS, ABSTRACTS AND OTHER PUBLICATIONS (for total award period)

Bogner, M., U. Ramamurthy, and S. Franklin. 2000. "Consciousness" and Conceptual Learning in a Socially Situated Agent. In *Human Cognition and Social Agent Technology*, ed. K. Dautenhahn. Amsterdam: John Benjamins. 113-135