Technical Status Report **October, 2002**

DARPA Agent Based Computing (ABC) Program, Taskable Agent Software Kit (TASK)

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Project: Multi-type, Self-Adaptive Genetic Programming for Complex Applications

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Accomplishments This Quarter

• Enhanced SwarmEvolve system for real-time evolution of goal-directed swarms of agents in several ways, including:

- Food consumption/growth
- Birth near mothers
- Corpses
- Food (target) sensor, inverse square signal strength
- GUI controls and metrics
- Feeders (targets) redesigned, increased in number

These enhancements, which increase both the complexity of the system and its correspondence to the OEF challenge problem, constitute "SwarmEvolve 1.5."

• Distributed SwarmEvolve 1.5 to U. Massachusetts TASK group for analysis (using their Proximity system).

• Demonstrated emergence of collective/multicellular organization and transitions to/from genetic drift regimes in SwarmEvolve 1.0. Documented in:

> Spector, L., and J. Klein. 2002. Evolutionary Dynamics Discovered via Visualization in the BREVE Simulation Environment. To appear in *Proceedings of the Workshop "Beyond Fitness: Visualising Evolution" to be held at Artificial Life VIII, the 8th International Conference on the Simulation and Synthesis of Living Systems.*
>
> Associated web page (*includes source code and movies*):
> http://hampshire.edu/lspector/alife8-visualization.html
> Full text:
> http://hampshire.edu/lspector/pubs/alife8-visualization.pdf

• Conducted preliminary investigation of SwarmEvolve food supply (a metric related to surveillance coverage in the OEF challenge problem) as a function of environmental stability and mutation rate. Preliminary data can be summarized as follows:

		MUTATION		
		low	med	high
STABILITY	low	54%	17%	18%
	med	43%	12%	10%
	high	55%	14%	12%

Lower numbers here indicate better evolved coverage. These data confirm some expectations (e.g. that adaptation suffers if stability or mutation rates are too low) but also points to some interesting areas for further study (e.g. the observation that too *much* stability impairs long-term adaptation because the system to an inflexible strategy that appears good in the short term. Investigation of this phenomenon is ongoing.

• Presented several of the items above to TASK workshop attendees (Santa Fe Institute, October 9-11) and other visitors (some from the co-located MICA meeting).
URLs for presentation slides:

PDF format: http://hampshire.edu/lspector/TASK-Oct2002-Spector.pdf
Powerpoint format: http://hampshire.edu/lspector/TASK-Oct2002-Spector.ppt

• Continued discussions with University of New Mexico TASK group, including an October 9 visit to the Albuquerque campus (in part to participate in the thesis defense of TASK participant Terry Van Belle).

• Produced first version of a C-language Push interpreter integrated into the BREVE simulation environment, a critical step in the eventual integration of the work on multi-type, self-adaptive genetic programming (Push, PushGP, and Pushpop) with the work on real-time evolution of goal-directed swarms of agents (in the BREVE simulation environment).

• Documented additional aspects of SwarmEvolve and related BREVE projects in:

Spector, L., and J. Klein. 2002. Complex Adaptive Music Systems in the BREVE Simulation Environment. To appear in *Proceedings of the Workshop "Artificial Life Models for Musical Applications II: Searching for musical creativity" to be held at Artificial Life VIII, the 8th International Conference on the Simulation and Synthesis of Living Systems.*
Associated web page:
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• Completed a book review related to quantum computing aspects of the project. (The search for quantum algorithms provides objectively hard problems for testing the developed genetic programming techniques.):

> Spector, L. 2003. Book Review: The Quest for the Quantum Computer, by J. Brown. To appear in Genetic Programming and Evolvable Machines (Kluwer Academic Publishers).

Current Plans

• Enhance complexity/realism/OEF integration.

• Species-specific controls and metrics.

• Structured target behavior; agent-responsive.

• Leverage Push/Breve integration for evolution of arbitrary agent control programs and group (species) distinctions.

• Integrate MIT/BBN elementary adaptive modules.

• Provide “evolution” components for Taskable Agent Software Kit.