Technical Status Report **July, 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

• Implemented the first version of a new system to evolve controllers for swarms of goal-directed agents in a complex 3D environment, using the Breve simulation environment. (Breve was produced by Jon Klein, who will be joining the Hampshire College TASK effort for the 2002-3 academic year.) A quicktime movie (file size = 10MB) showing some of the evolved agents is available at http://hampshire.edu/lspector/SwarmJune10.1.mov. A demo of this system was presented at the Chicago TASK PI meeting and another demo was presented at the *Workshop on Evolutionary Computation for Multi-Agent Systems, ECOMAS-2002*.

• Used the PushGP self-adaptive genetic programming system to evolve transport network control agents (part of a collaboration with the MIT/BBN TASK group) and analyzed the performance of the resulting agents. Presented these results at the *Workshop on Evolutionary Computation for Multi-Agent Systems, ECOMAS-2002*. Documented in:

> Spector, L., and A. Robinson. 2002. Multi-type, Self-adaptive Genetic Programming as an Agent Creation Tool. In *Proceedings of the Workshop on Evolutionary Computation for Multi-Agent Systems, ECOMAS-2002*, International Society for Genetic and Evolutionary Computation.
> http://hampshire.edu/lspector/pubs/ecomas2002-spector-toappear.pdf

• Confirmed a result by Van Belle and Ackley (the UNM TASK group) demonstrating the ability of an evolutionary computation system to use modularity to better adapt to a changing environment. This is in some senses a stronger result than Van Belle and Ackley's, as they pre-determined the modular architecture while PushGP was able to find an adaptive modular architecture autonomously. Presented these results at the *ECOMAS-2002* workshop, with documentation in the *ECOMAS-2002* paper cited above.

• Used the PushGP self-adaptive genetic programming system to evolve decentralized and coordinated navigation strategies in the "Opera" multi-agent systems problem (part of a collaboration with the Dartmouth TASK group). Presented these results in the late-breaking paper session of *GECCO-2002, the Genetic and Evolutionary Computation Conference*. Documented in:

> Robinson, A., and L. Spector. 2002. Using Genetic Programming with Multiple Data Types

and Automatic Modularization to Evolve Decentralized and Coordinated Navigation in Multi-Agent Systems. In *Late-Breaking Papers of GECCO-2002, the Genetic and Evolutionary Computation Conference*. Published by the International Society for Genetic and Evolutionary Computation.
http://hampshire.edu/lspector/pubs/opera-gecco-lbp.pdf

• Improved the scalability of the PushGP self-adaptive genetic programming system by use of "size fair" genetic operators that control program growth without negative impacts on problem-solving performance. Raphael Crawford-Marks presented these results at *GECCO-2002*. Documented in:

Crawford-Marks, R., and L. Spector. 2002. Size Control via Size Fair Genetic Operators in the PushGP Genetic Programming System. In W. B. Langdon, et al. (editors), *Proceedings of the Genetic and Evolutionary Computation Conference, GECCO-2002*, pp. 733-739. San Francisco, CA: Morgan Kaufmann Publishers.
http://hampshire.edu/lspector/pubs/size-control-toappear.pdf

• Presented a tutorial on "Quantum Computing for Genetic Programmers" at the Genetic and Evolutionary Computation Conference, *GECCO-2002*.

• Presented a poster at the Sixth International Conference on Quantum Communication, Measurement and Computing (*QCMC02)*, called "Communication through certain quantum gates of interest, discovered in part by genetic programming." A paper will be prepared for the proceedings, to be published in the Fall.

• Revised paper for publication in the proceedings of *Artificial Life VIII, The 8th International Conference on the Simulation and Synthesis of Living Systems*. The title of the paper is "Adaptive populations of endogenously diversifying *Pushpop* organisms are reliably diverse." This paper addresses the evolution of reliably diversifying reproductive systems, an important requirement for self-adaptive evolutionary computation systems with strong problem-solving capabilities.

Current Plans

• Enhance complexity/realism of environments for agent evolution.

• Build capability for evolution of arbitrary (Push) agent programs into 3D Breve environment.

• Integrate MIT/BBN elementary adaptive modules (EAMs) into agent evolution system.

• Provide "evolution" components for Taskable Agent Software Kit.

• Assess utility of components made available to evolution, including EAMs and other components.