Technical Status Report and Project Summary **August, 2004**

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

PI: Lee Spector, Hampshire College

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

Project URL: http://hampshire.edu/lspector/darpa-selfadapt.html

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This document is a cumulative summary of materials for quarterly reports for three quarters: Oct-Dec 2003, Jan-Mar 2004, and Apr-Jun 2004. This document was prepared August 27, 2004.

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Progress

Completed development of the UAV simulator and simulation scenarios in the breve simulation environment, in conjunction with the University of Massachusetts DARPA TASK group (Jensen et al.).

Used the PushGP genetic programming system to evolve high performance UAV surveillance strategies that out-performed human-designed strategies. Prepared demo materials demonstrating this performance for August DARPA demos.

Developed and implemented several major enhancements to the Push programming language for evolutionary computation, resulting in higher problem-solving potential for genetic programming systems such as PushGP.

Developed a C++ implementation of the QGAME Quantum Gate and Measurement Emulator. In conjunction with the C++ implementation of PushGP this supports high performance automatic quantum computer programming by means of genetic programming. See http://hampshire.edu/lspector/qgame.html.

Developed several major enhancements to the breve simulation environment, version 2.0 of which will soon be distributed. See http://www.spiderland.org/breve.html. Among the many new features (several of which were critical for the UAV simulation for the DARPA TASK demo) is a new ability for users to write breve simulations in any programming language. This will broaden the applicability of the technology.

Co-evolved strategies for teams of agents in complex, 3D environments. Additional information available from: http://hamp.hampshire.edu/~rpc01/vww.html. Additional movies at: http://hampshire.edu/lspector/quidditch-movies/.

Co-organized the AAAI 2004 Fall Symposium on Artificial Multi-Agent Learning, which will take place this coming Fall.

Served as track chair for the genetic programming track of the Genetic and Evolutionary Computation Conference (GECCO-2004) and as co-editor of the proceedings.

The PI received a "Gold Medal" prize in the GECCO-2004 Human-Competitive Results contest. Additional information is available at: http://www.genetic-programming.org/gecco2004hc.html.

The PI was elected a Fellow of the International Society for Genetic and Evolutionary Computation. A press release is available at: http://hampshire.edu/lspector/human-competitive.pdf.

The PI was re-elected to the Executive Board of the International Society for Genetic and Evolutionary Computation.

Publications

Book: *Automatic Quantum Computer Programming: A Genetic Programming Approach* by Lee Spector, Kluwer Academic Publishers, 2004. More information is available from http://hampshire.edu/lspector/aqcp/. This book includes descriptions of work conducted as part of this effort.

Proceedings editor: Deb, K., R. Poli, W. Banzhaf, H-G Beyer, E. Burke, P. Darwen, D. Dasgupta, D. Floreano, J. Foster, M. Harman, O. Holland, P. Lanzi, L. Spector, A. Tettemanzi, D. Thierens and A. Tyrrell, editors. 2004. *Proceedings of the Genetic and Evolutionary Computation Conference, GECCO-2004*. Lecture Notes in Computer Science, Vol. 3102-3103, Springer-Verlag.

Spector, L., C. Perry, J. Klein, and M. Keijzer. 2004. Push 3.0 Programming Language Description. http://hampshire.edu/lspector/push3-description.html.

Crawford-Marks, R., L. Spector, and J. Klein. 2004. Virtual Witches and Warlocks: A Quidditch Simulator and Quidditch-Playing Teams Coevolved via Genetic Programming. In *Late-Breaking Papers of GECCO-2004, the Genetic and Evolutionary Computation Conference*. Published by the International Society for Genetic and Evolutionary Computation. Paper available from: http://hampshire.edu/lspector/pubs/ virtual_witches_and_warlocks.pdf.

Spector, L., J. Klein, C. Perry, and M. Feinstein. To appear. Emergence of Collective Behavior in Evolving Populations of Flying Agents. In *Genetic Programming and Evolvable Machines*.

Spector, L., J. Klein, and C. Perry. To appear. Tags and the Evolution of Cooperation in Complex Environments. In *Proceedings of the AAAI 2004 Fall Symposium on Artificial Multi-Agent Learning*.

The Push interpreter and the PushGP and Pushpop genetic programming systems, along with the QGAME quantum computer simulator have been made available by the PI (Lee Spector, lspector@hampshire.edu). The BREVE simulation environment is also freely available on the web, as is source code for several of the other systems developed in this effort (see the project web page). All developed technologies will be described in publications stemming from the project.

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Visits and Talks

Several visits to UMass for joint work on UAVolve system for the evolution of high performance UAV surveillance strategies. Also discussed planning for August demo.

Presentation on human competitive results in *Automatic Quantum Computer Programming: A Genetic Programming Approach* at the Genetic and Evolutionary Computation Conference. Award gold medal prize.

Presentation on "Virtual Witches and Warlocks: A Quidditch Simulator and Quidditch-Playing Teams Coevolved via Genetic Programming" at the Genetic and Evolutionary Computation Conference.

Presented a tutorial on Genetic Programming (with John Koza) at AAAI, the National Conference on Artificial Intelligence.

PI meetings and August demo.

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Plans

Participate in the AAAI 2004 Fall Symposium on Artificial Multi-Agent Learning, which the PI co-organized and which will take place this coming Fall.

Finalize implementation, testing, and dissemination of Push3, BREVE 2.0, and QGAME++.

Continue preliminary work with UMass TASK group on the evolution of cryptic strategies, with evolution handled by PushGP and crypticity assessed via PROXIMITY.

Complete several publications on the evolution of cooperation and collectivity in multi-agent systems. Several of these employ the SwarmEvolve systems developed as part of this effort.

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Problems/Concerns

None.