Survival of the Fastest: Using Cultural Algorithms to Optimize the Design of a Controller for a 3D Racing Game

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Abstract:

This talk describes the use of a socially motivated evolutionary algorithm, Cultural Algorithms, to design a controller for a 3D racing game for use in a competitive event held at the 2008 IEEE World Congress in Hong Kong. Cultural Algorithms were used to generate a set of control rules for an autonomous driver to compete in the event. The driver was modeled as a state machine and rules were associated with actions that can be taken in each state. The Cultural Algorithm consists of a Population Space, a Belief Space, and a communication protocol connecting them together. Here the population was viewed as a network of chromosomes whose aggregate behavior was generalized in the Belief Space. The knowledge sources in the belief space vie to control individuals in the population through the social fabric influence function. The LBert configuration was employed to train the system on an example oval track prior to the contest but it did not generalize well to other tracks. Next, how other topologies performed when learning on each of the contest tracks will be discussed. The square network worked best at distributing the influence of the knowledge sources across the network, and reduced the likelihood of premature convergence for complex tracks.

Biography:

Dr. Robert G. Reynolds received his Ph.D. degree in Computer Science, specializing in Artificial Intelligence, in 1979 from the University of Michigan, Ann Arbor. He is currently a professor of Computer Science and director of the Artificial Intelligence Laboratory at Wayne State University. He is an Adjunct Associate Research Scientist with the Museum of Anthropology at the University of Michigan-Ann Arbor. He is also affiliated with the Complex Systems Group at the University of Michigan-Ann Arbor and is a participant in the UM-WSU IGERT program on Incentive-Based Design. His interests are in the development of computational models of cultural evolution for use in the simulation of complex organizations and in computer gaming applications. Dr. Reynolds produced a framework, Cultural Algorithms, in which to express and computationally test various theories of social evolution using multi-agent simulation models. He has applied these techniques to problems concerning the origins of the state in the Valley of Oaxaca, Mexico, the emergence of prehistoric urban centers, the origins of language and culture, and the disappearance of the Ancient Anazazi in Southwestern Colorado using game programming techniques. He has co-authored three books; Flocks of the Wamani (1989, Academic Press), with Joyce Marcus and Kent V. Flannery; The Acquisition of Software Engineering Knowledge (2003, Academic Press), with George Cowan; and Excavations at San Jose Mogote 1: The Household Archaeology with Kent Flannery and Joyce Marcus (2005, Museum of Anthropology-University of Michigan Press).
He has received funding from both government and industry to support his work. He has published over 250 papers on the evolution of social intelligence in journals, book chapters, and conference proceedings. These include IEEE Computer, IEEE Computational Intelligence, Complexity, Scientific American, IEEE Transactions of Evolutionary Computation, IEEE Transactions on Systems, Man, and Cybernetics, IEEE Software, Communications of the ACM, and the Proceedings of the National Academy of Sciences. He is also co-editor of four books on evolutionary computation. Recently, a paper co-authored with M. Ali was selected as the Best Paper of 2008 in the International Journal of Intelligent Computing and Cybernetics.

Dr. Reynolds currently teaches courses on game programming, evolutionary computation, and agent-based modeling. In addition he has given a number of tutorials on Cultural Algorithms, including the IEEE 2007 Spring Symposium on Computational Intelligence.

He is currently an associate editor for the IEEE Transactions on Computational Intelligence in Games, IEEE Transactions on Evolutionary Computation, the International Journal of Artificial Intelligence Tools, International Journal of Computational and Mathematical Organization Theory, the International Journal of Software Engineering and Knowledge Engineering, and the Journal of Semantic Computing. He is also a program co-chair for the 2008 IEEE World Congress on Computational Intelligence, program co-chair for 2008 IEEE Swarm Intelligence Symposium, on the Advisory Board for the International Swarm Intelligence Symposium (2007, and current President of the Evolutionary Programming Society among other activities.