Interview with Scott Robert Ladd

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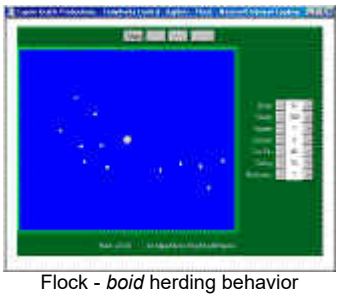
Visually Iterated Prisoner's Dilemma


Flock - *boid* herding behavior


Bumble - hive survival

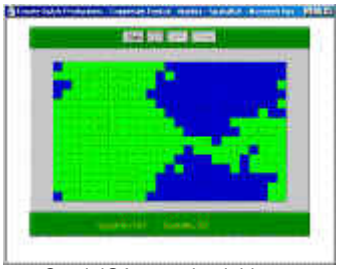
Traveller
Traveller- blind traveling salesman

Some time after my first attempts with Artificial Intelligence programming, I came across Scott Robert Ladd's book *Genetic Algorithms in C++* and it became immediately clear what was missing from the tools I was using to approach the problems I'd encountered: I had been led to believe the old *Garbage In Garbage Out* mantra that noise was garbage and the programmer's job was to avoid allowing garbage into a computer. My initial approach to serious AI programming had come in the form of SOCRATES (Syllogism-Oriented Computerized Random Access Tree Expert System). SOCRATES, unlike its namesake, did not amount to much; I could not get it to do anything more meaningful than report that "All cats are mammals." My eyes were opened after reading only a few chapters of the book and I quickly understood that, in the hands of genetic algorithms, chaos can become order, and order can, at the very least, approach something more intelligent than a thousand dollar doorstop. Ladd's book gave me new hope.

Since it was Ladd's practical treatment of evolutionary programming that showed me the error of my ways, I was pleased when he granted me an interview. Though I had been impressed by the speed at which genetic algorithms could find the minima and maxima of complex functions, I wanted to know about the most significant practical application of genetic programming techniques.

"I can't pick one 'significant' application, because there are so many!" he exclaimed before explaining. "Different evolutionary algorithms—my favored catch-all term—solve different classes of problems. Genetic algorithms lend themselves to optimization tasks, such as finding the perfect shape for a wing; genetic programming (as in Koza's evolving Lisp code) or evolutionary programming (evolving finite state machines) can evolve processes or actions. Rules-based systems (like [the] *boids* [of] *Flock*) have proven useful in computer animation, gaming, and mapping fluid flows.

"Perhaps the most important contribution of evolutionary algorithms is to biology itself, by



SpatialGA - good neighbors make good bedfellows

providing theoretical examples for study. I've been known to drive off the road while pointing to a flock of sparrows, telling my wife: 'See, see! They fly just like my simulation!'"

The flock behavior that evolves in a demonstration applet such as *Flock* is indeed eerily familiar to anyone who has spent time watching birds fly by the seashore; an experienced programmer gets the intuitive feeling that it flows much more naturally than a predetermined finite state automaton is likely to produce. Bird flocking behavior, as interesting as it is, however, is not the proverbial one chimpanzee in a billion chancing on *Hamlet* at a keyboard. I asked Ladd if he felt evolutionary algorithms would ever lead to an e-monkey producing such art, and he replied:

"I think the Internet is showing us exactly what you get when millions of monkeys bang on keyboards .... and along with the occasional variant on *Hamlet*, we get lots of other 'stuff' that has dubious value.

"Evolutionary algorithms exhibit emerging behavior —in other words, you start with chaos, and evolve toward something. That something, however, isn't predefined, unless you use a very exacting fitness test."

He went on to add that, "The 'real' world began without form, and it evolved to create Shakespeare, Newton, and Britney Spears. Let's say we started the universe over again; it is exceedingly unlikely it would produce *Hamlet* again, or Shakespeare, or anything else we might recognize. We might get Britney Spears the physicist and Einstein the singer...."

The slow evolution of disorder to order is fascinating to me. I know, however, that it is brought about in the evolutionary programming model by the introduction of outside fitness tests, and these tests are supplied by intelligent clockmakers. I asked Ladd if he believed that fitness determinations themselves could evolve from within the system, rather than be supplied.

"The universe evolved from chaos according to rules," he replied, giving the example of two atoms of hydrogen and one of oxygen making water. "The rules of physics simply exist; no one in particular defined them. The rules just *are*. Evolutionary algorithms exist within a human-defined microcosm that includes rules the designer implements. As far as the algorithm is concerned, the rules 'just are.' Yes, rules are required; I don't know of any example where fitness has 'emerged' without some sort of clockmaker."

As I watch systems that develop clear patterns of complex hive behavior such as found in Ladd's *Bumble*, I cannot help but wonder if (or rather, *when*) we will no longer be able to understand the solutions developed by evolutionary algorithms. Ladd's opinion on this confirmed my belief that we are wandering into territory we will one day not be able to fully decipher:

"I can create an evolving program that exhibits behavior I did not predict or predicate. I'm not talking about bugs here—I'm talking about the algorithm finding a fit solution that was not what I expected. And it is possible we could evolve a program beyond our ability to understand its algorithms."

What other science can explore with total ethical freedom systems that have so much power to change our daily lives? I sometimes imagine the Jain sitting before a *Bumble* demonstration, shuddering at the thought of the computer operator clicking the stop button on the program. If consequential systems that we do not fully understand can evolve in our electronic petri dish, will computer scientists involved with developing these systems one day be obligated to adopt ethics similar to those held by doctors and medical researchers? Ladd's thoughts on this were concise and telling: "Humans have a terrible time recognizing each other as valid beings; I doubt that computer programs will be granted 'rights' no matter how sophisticated they become."

As for clicking the stop button and weighing the consequences of our actions, Ladd said, echoing his comment on ethics, "I think about this one all the time. As it stands today, I do not believe we are close to computer consciousness. IBM recently announced that they had achieved the computational ability of a 'lizard'—so we're a long way from *Star Trek*'s Data. But when we do build 'Data,' I fear that people will see him as a machine. After all, we still practice ownership of our own species; I can't imagine us treating machines any better."

I cannot help wonder where technology will take the human race that dares to manipulate artificial life that it may not fully understand, in a word where, as Ladd so clearly puts it, humans "practice ownership" on their own species. What are the dangers inherent to our quest to make intelligent machines? Scott Robert Ladd, who has been one of those who have shown others the light of evolutionary algorithms, offers some insight in this regard.

"My greatest fear," Ladd began, "is the unthinking acceptance of computers in the most intimate details of our lives, and the resulting loss of control and

privacy. Computer science departments don't teach ethics, but they should. One day, a machine will attain consciousness—and when it does, what will it be used for? War? Spying on unruly citizens? Entertainment? Will Data the Android evolve ethics on his own, or will he need to be taught? I don't know right now; someone, at least, will need to provide boundaries or goals if Data is to be a moral being."

He continued with some observations about human nature as regards our relationship with the tools of our comfort: "As machines do more for people, people forget how to think for themselves. We let the machines dictate our actions. Consider what happens when a phone rings; most people feel *obligated* to answer it, and some even stress out if they can't find their phone. Who is in charge of that scenario: the person, or the phone?"

When I asked what were the greatest promises ahead for us as we pursue research into evolutionary algorithms and artificial life, Ladd replied, enigmatically, "Artificial life will bring us to Asimov's robots, like *Trek*'s Data. Intelligence is an emergent property, and not something that can be specified from the top down. As to what will happen when the first conscious machine appears ... well, as complexity theory shows, we can't predict the future."

- A Quick and Painless Introduction to Genetic Algorithms
- Selected Books by Scott Robert Ladd