Students — and robots — learn in professor´s robotics lab

by Julie Wernau

Not every robot goes on to explore Mars. Some of them end up in Director of Computer Science Gary Parker´s cabinet of misfits.

Like the disk-shaped robot that fell one too many times. Or the still-recovering flying machine that flew too hard and too fast before it had learned to control its propellers.

These electronic creatures reside in a small space in Winthrop Annex that has been set aside for an “artificial intelligence and robotics lab.” The robots, designed and built by Parker´s students, are lined up on towering shelves like some kind of futuristic toy store.

While they may look like toys — or like villains from a futuristic science fiction film — they are actually sophisticated research tools that Parker and his students use for cutting-edge research in artificial intelligence.

Based on a computerized version of two laws of nature — survival of the fittest and heredity — the codes that control the robots are able to evolve through generations of selection and reproduction. Within an hour, a wobbly robot named Frank (short for Frankenstein) evolved through 500 generations of control codes as he attempted to walk across a table. By the final generation, the ant-like robot could easily saunter from one end of the table to the other using the coded instructions or artificial “genes” that had been generated on a nearby computer.

See video of "Frank" walking *(Quicktime required):*

Randomly, no learning -- After 200 generations -- After 500 generations

A camera above the lab is set up to observe the process Parker calls “punctuated anytime learning,” a fancy way of saying that by observing the performance of the robots and communication from a learning computer, robots like Frank are perfecting a set of skills.

Parker made modifications to the standard genetic algorithm to invent the cyclic genetic algorithm (CGA), a method by which cycles of behavior can be learned through self-generated code. In real life, this means that a robot that encounters mud, for instance, might adapt with a different gait. A robot that loses a leg could learn to walk without it.

To demonstrate, Parker changed the parameters on the computer to tell one robot that it was suddenly carrying a heavy load. The robot took on a new walk — slow, deliberate and heavy on stability. In further tests, he showed how the CGA could adapt the robot control codes for partial and full loss of one or two of its legs. “The original CGA method was very limited because it couldn´t react to sensory input,” Parker said.

Parker imagines that the CGA method, along with punctuated anytime learning, could one day be used to help robots to explore other planets. Dozens of small robots could be sent on a Mars mission; they would be self-controlled, but the learning would take place in a single satellite computer hovering above. These robots would be much less expensive than ones with onboard learning systems, yet they would have the ability to adapt to changes in their capabilities and the environment.

In the lab, Parker´s undergraduate students perform graduate-level artificial intelligence and robotics work that contributes to his decades of research. In fact, Parker´s student researchers have co-authored 21 papers on robotics in just the past five years.
Basar Gulcu ´08 has spent the summer researching robot interactions in the lab. In his experiments, the robots are learning together to mimic “predator and prey.”

Working in the robotics lab, said Gulcu, “was like a dream come true, but I hadn´t dreamed this far. I never knew robotics research was done in a small liberal arts college. Yet we have the opportunity to apply what we have learned in the courses to do graduate level research.”