Computer-simulated life forms evolve intelligence

Computer-simulated life forms which reproduce themselves inside their electronic world have evolved to produce basic intelligence.

By Tom Chivers (http://www.telegraph.co.uk/journalists/tom-chivers/)
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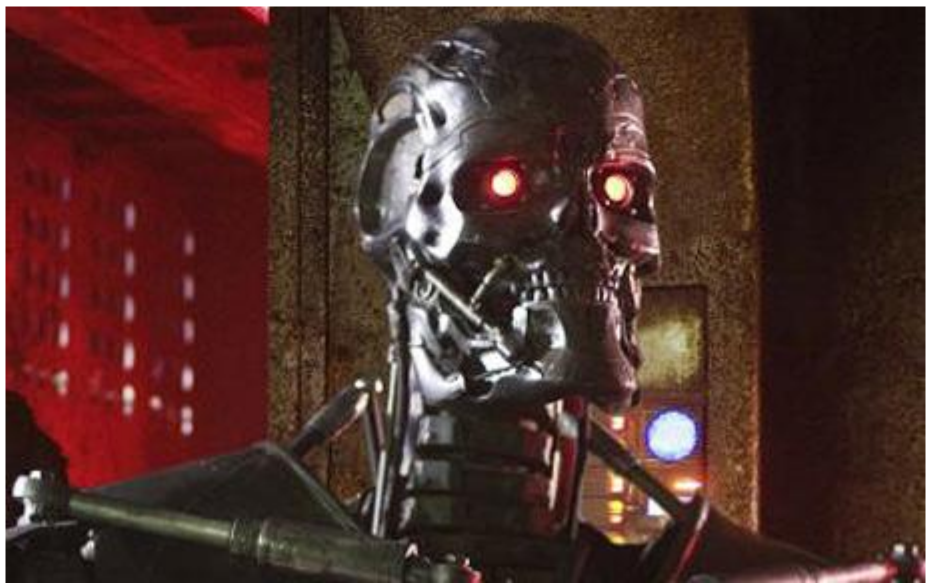
Probably not what the evolved robot Avidians look like.

It is hoped that the discovery may in future lead to artificially intelligent brains "bred" within a computer.

The "Avidians", a race of digital beings in a computer world called Avida (http://avida.devosoft.org/) run by scientists (http://www.telegraph.co.uk/science/) at Michigan State University, with computer code instead of DNA that is copied - not quite perfectly - every time they breed. The random copying errors create differences in their code which dictate how well, or badly, they will perform in their simulated world.

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Early experiments put the Avidians on a grid of cells, and let them live and die there. The grid had a gradient of food - cells at one end have more than the ones at the other, where the Avidians begin. After 100 generations of breeding, a mutation led to one of them evolving a "gene" instructing it to move forward. When it landed in a more food-rich cell, it reproduced more quickly, and had more offspring than its rivals.

After thousands more generations, the Avidians had evolved something more impressive: a rudimentary memory. They had started moving towards the food source in a zig-zag motion, changing direction when they were going in the wrong direction. To do that, they had to be able to compare their current cell to the previous one. Robert Pennock, one of the scientists behind the experiments, told New Scientist (http://www.newscientist.com/article/mg20727723.700-artificial-life-forms-evolve-basic-intelligence.html?page=1) : "Doing this requires some rudimentary intelligence. You have to be able to assess your situation, realise you're not going in the right direction, reorient, and then reassess."

A later experiment added a new twist: cells that contained instructions on where to go to find food. Some of those instructions were simply "do what you did in the last cell". In order to make sense of those instructions, Avidians had to evolve a more complex memory - and duly did so. Laura Grabowski, another of the researchers, said: "The environment sets up selective pressures so organisms are forced to come up with some kind of memory use - which is in fact what they do."

This sheds some light on how intelligence originally evolved: MSU zoologist Fred Dyer says: "Laura's work suggests that the evolution of an ability to solve simple navigational problems depends on first evolving a simple short-term memory - and this in digital organisms that still don't exhibit something you would call learning." But the findings may, in the future, allow researchers to create true artificial intelligence.

Dr Grabowski says: "In the past, the approach has been to start with high-level intelligence and reproduce that in a computer.

"This is the opposite. We're showing how complex traits like memory can be built from the bottom up, from things that are really very simple."

She demonstrated this by getting Avidians to evolve an attraction to light sources. She then used the evolved code to control a real-world robot - and it moved towards the light.

Another team, led by Jeff Clune, another MSU scientist, is attempting to create more complicated intelligence through evolution. His system, called HyperNEAT, is made of computer-simulated "neurons", the role of each of which is determined by equations based on the cell's position within the simulated "brain". This allows complex brains to be built up from relatively simple instructions. Further, you can change those instructions, and get a different brain.

Dr Clune tests each brain in a virtual robot, and gets them to perform tasks like moving across a surface. He picks the brains that do well at the task, and then makes copies of them, with the random errors in the instructions that, as with the Avidians, lead to evolution. He has found that his evolved brains have become better than traditional neural network brains at the tasks he sets. He says: "Brains that have been evolved with HyperNEAT have millions of connections, yet still perform a task well, and that number could be pushed higher yet.

"This is a sea change for the field. Being able to evolve functional brains at this scale allows us to begin pushing the capabilities of artificial neural networks up, and opens up a path to evolving artificial brains that rival their natural counterparts.

"That is a lofty long-term goal, of course, but this technology allows us to start marching towards it."

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Hello paulweighell-

The HyperNEAT technology is actually cutting-edge, and represents a major innovation versus previous neuroevolution techniques. One major thing that differentiates it from things like neuroevolution with Radial Basis Functions is that HyperNEAT is based on concepts from developmental biology. Specifically, it evolves compositions of geometric coordinate frames that are abstractions of the diffusing chemical gradients of developing embryos. These concepts enable the evolution of regular patterns in neural wiring that have not been seen before in neuroevolution (see, for example, the pictures of evolved brains in my dissertation, which is available at my website). The ability to generate regular wiring patterns enables evolution to search in a small search space of short genomes, yet produce functioning brains with millions or more connections. Of course, this article was written for the popular press, so they did not have the ability to get to this level of detail.

It sounds like you know a lot about evolutionary computations and neural nets. I encourage you to read the publications about HyperNEAT, either at my website or at those of other researchers using the technology (e.g., the University of Central Florida). I think you'll then be impressed by the breakthroughs in HyperNEAT.

You are correct that evolutionary computation itself has been around for a while. But the science described in this article is pushing that technology further.

Best,
Jeff Clune
Postdoctoral Scientist
Michigan State University
Report (#) Recommend (#)

paulweighell (http://my.telegraph.co.uk/members/paulweighell)
Yesterday 11:25 PM
Recommended by
2 people
I was amazed to read this. It is so out of date.

Since 1995 we have been supplying this technology to evolve derivatives trading algorithms and I know at least one bank using the same technology to evolve currency-trading algos.

After a few thousand generations the algorithms produced by computer based evolution really are self-evolved intelligent solutions very well fitted (in the Darwinian sense) for the environments we give them. They are way beyond those that man could devise in anything like the same time.

Whilst not common perhaps this technology really is already quite widespread and I am rather appalled it has taken Michigan State University so long to catch on to the concept, if the article here really is accurate.

The 'HyperNEAT' system it mentions sounds like a large radial basis function neural network trained by GA, again rather old hat these days...

The hard part is not to create limited specialised machine intelligence as described here but to harness its output to the real world and solve useful problems.

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