

THE NEW FRONTIER

KEN KARAKOTSIOS

When I was growing up, I read a lot of science fiction, catching glimpses of worlds unlike anyplace we'd ever been, worlds that existed only in our minds: Living in domes under the ocean, sailing across the sands of Mars, debating with machines that could think, flying across the universe to meet bug-eyed aliens. To a young kid living in the glow of the space age, where we were already on the Moon, it seemed that Mars was just a few years away, and certainly we'd be traveling to other stars by the end of the century. And computers surely were already thinking, weren't they?

Well, technology didn't quite keep up with a twelve-year-old's ambitions, and as I went through high school and college, and began working, I came to realize a few things:

- Most of us will never physically travel to any destination off the Earth's surface
- Humans are never going to be able to design machines smarter than themselves
- Life is pretty futile if everything we experience is lost when we die
- Math is really interesting

It's only now that I can look back and see how this strange mix of ideas would lead me towards a truly new frontier that we can visit. I caught my first glimpse of the new frontier in the late 1970's, when I read an article about something called The Game of Life. This isn't a game in the traditional sense, because there is no way to win or lose. Yet the outcome is surprising enough to compel you to play. Life is played on a large grid of squares. Each of these squares can either be empty, or contain a stone. There's a clock running, and with each tick of the Clock, every square in the grid "looks" at its eight neighboring squares, and applies one of the following two "rules":

- If the central square is empty, and exactly three of its neighbors have stones, then a stone will appear in the central square.
- If the square does have a stone, and exactly two or three neighbors also have stones, then the central square will keep its stone. Otherwise its stone disappears.

These rules are simple and repetitive, and sound rather uninteresting. But when you program the game on a computer and start the clock running, something amazing happens ... Order is created out of randomness. Static, oscillating, and traveling patterns form from the primordial goo. Pattern interacts with pattern, spawning both higher level patterns and randomness. But this randomness is food for another generation, and on and on the dance continues.

The emergent behavior of this toy system hinted that there was something lurking out in the cyberspace frontier. Something that already existed in the abstract world of mathematics, something that we could catch a glimpse of with our computers. It was clear that I needed to look at something more complex than stones on a grid. Thus began SimLife.

GET A LIFE!



SIM LIFE THE GENETIC PLAYGROUND BREAKS THE BARRIERS BETWEEN GAMES AND SIMULATIONS, PLAYING AND LEARNING—EVEN BETWEEN MACHINES AND LIVING BEINGS. SINCE AGAIN, MAXIS, THE CREATORS OF SIMCITY® AND SIM-EARTH®, TAKES YOU WHERE YOU'VE NEVER BEEN AND GIVES YOU THE POWER TO CREATE—THIS TIME TO CREATE LIFE ITSELF.

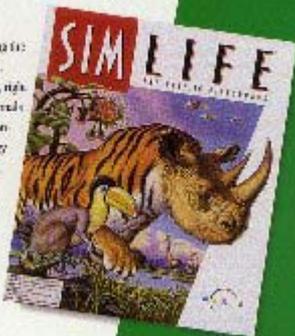
SIM LIFE IS FUN. Your design decisions have the depth of your imagination, and influence how they look, act and eventually evolve. Then, set your focus on your chosen ecosystem, and test their ability to survive. Six different game scenarios challenge you to solve problems involving everything from food chain management to genetic manipulation.

SIM LIFE IS EXPERIMENTAL. Design your own experiments using simulated environments, ecosystems, genetics, evolution, life and behavior. You can even run cloning and gene-splicing tests to cause and effect of your decisions and observe the subtle relationships that form between living beings.

SIM LIFE IS ARTIFICIAL. Using the latest advances in artificial life research, SimLife simulates a complete ecosystem, right down to individual genes. Plants and animals interact with each other and their environment. This is not the "real world"—they are virtual and made to your specific needs.

In SimLife, you are the creator to create the natural world, but beware—it's up to you to keep your species of the unaltered life.

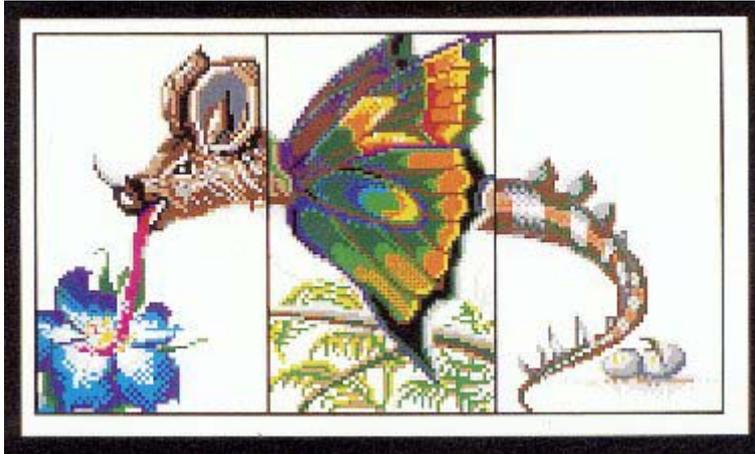




PUBLISHED BY
MAXIS

SimLife is a program in which digital organisms, in the form of plants and animals, compete to survive and produce offspring in a virtual universe. Like our world, the SimLife world has mountains, lakes, soil and climate. SimLife creatures need food to grow and produce offspring. Each creature is encoded with its own genetic description, and through sexual recombination each generation of creatures begets a new generation that has new combinations of the genes. Mutation helps to add a bit of variety to each new generation. The offspring best able to find food, mate, and produce another generation of viable offspring will by definition be the fittest, and their genes will travel into the future, leaving the less fit behind.

Simlife's 64 species don't quite match the diversity of Earth's estimated 30 million species. And while real animals have tens of thousands of genes, SimLife animals have only 46. While real life has had hundreds of millions of generations in which to evolve, SimLife needs to do its stuff in "real-time" so that we can watch it and interact with the process on a personal computer. Furthermore, the SimLife universe is equivalent to a patch of land just a few miles on a side. Yet with all these limitations, an amazing thing happens in SimLife: It works. Plants and animals evolve. Diverse ecosystems form food webs, symbiotic relationships, and population cycles. Higher-level emergent behaviors of real living systems, things I wasn't even aware of when I wrote the program, form on top of all this.



Although limited in many ways, SimLife removes some of the limits of the real world. Because all of SimLife's creatures are digital, they are open to inspection at all times. We can take instant snapshots of the entire gene pool of a population, without disturbing the system in the least — imagine trying to do that with a population of real animals. In SimLife, we can alter the genome of all the members of an entire species through a single click of the mouse. And if we get bored with the world we created, we can create another. We can change the laws of physics, metabolism and genetics at the slightest whim. Like The Game of Life, there's no winner or loser in SimLife; rather the reward is in exploring.

While SimLife gets us a little closer, it's still a long journey to the new frontier. While we do have emergent behavior, with tiny digital creatures evolving and adapting to an ever changing world, metabolizing digital food, the destiny of the creatures is rather limited. They are never going to develop a different body chemistry, invent fire, or build a starship. But SimLife is just the start.

In *The Selfish Gene*, Dawkins talks about something called "memes." As genes are the particles of biological inheritance, memes are particles of cultural inheritance. Memes are like ideas, but with a difference. As genes must replicate themselves in a new generation to survive, memes must also replicate themselves. Thus, to be a meme, an idea must cause a person to communicate it to other people. Memes also mutate and have sex. We've all experienced the combination of two ideas in a single new one. For example biology combined with computer science has given us artificial life. We only have a limited capacity to remember and communicate our memes, so we save and pass on the best ones, while forgetting the rest. This selection process keeps the most fit memes "alive" at the expense of eliminating the rest.

Biological genetics only allows new solutions to the problem of survival to occur once a generation. However, man is able to use speech to pass on new survival strategies in seconds rather than years. This is a million-fold speedup in the process of evolution. Broadcast telecommunication allow memes to reach millions of people simultaneously, and books and electronic storage allow us to extend the reach of our memes directly to people who may not even be born yet. This gives the meme quite an advantage over the gene. Our destiny becomes less dependent on a sequence of amino acids we have no choice in accepting, and more dependent on what we choose to believe, communicate, and do. We are the first species on earth to reach the post-biological phase of cultural evolution.

I believe that cultural evolution is a promising new direction to explore. By developing an artificial life world in which culture can evolve, a path may be found to evolve true

intelligence in software agents. What does this mean for the new frontier? It means that we have a chance of not just looking in like voyeurs through a glass CRT or virtual reality setup, but of being there. If we can evolve software agents that can think, and if we can unravel how we think, then by mapping our thoughts, experiences, and memes onto these software agents we will be able to upload ourselves into the new frontier. Electrons never die, and the novelty will be endless.