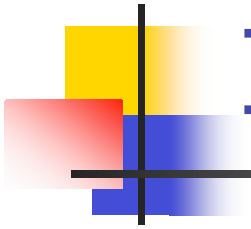
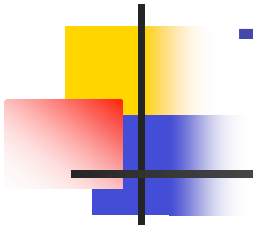
Computer Viruses, Artificial Life & the Origin of Life

Robert C Newman



Introduction

- Many talk today as though life came about by purely natural processes, and it's only a matter of time until we learn how it happened.
- Here we suggest that life is far more complex than most people think, and it is hardly likely to have happened by chance.



Topics of Discussion

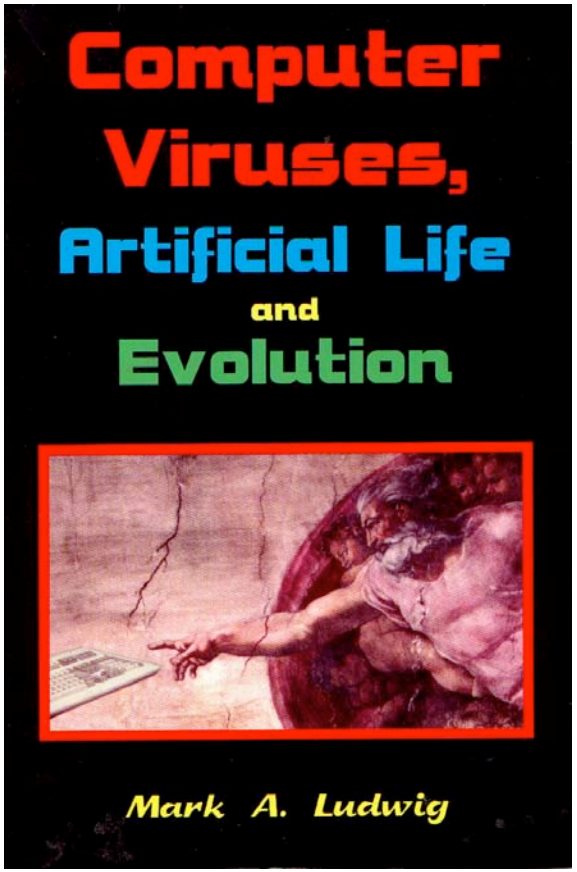
- In thinking about the complexity of life, we will take a different tack than is usual.
- We will look at computers rather than biology.
- We want to look at:
  - Computer Viruses
  - Artificial Life

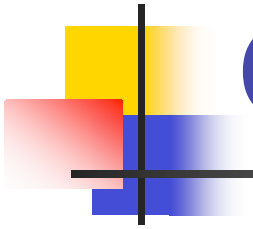
Computer Viruses

- What are computer viruses?
- Computer programs which invade a computer and try to take over its functions, rather like biological viruses do with human cells.
- Most of us with much computer experience have had to deal with such viruses from time to time.

Computer Viruses

- Excellent discussion in Mark Ludwig, *Computer Viruses, Artificial Life & Evolution.*
- CVs are closer to artificial life than anything else humans have made.
- They are able to reproduce.
- They can often hide from predators.
- They can survive outside captivity.

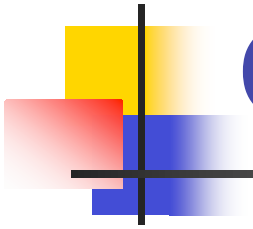




Origin of Computer Viruses

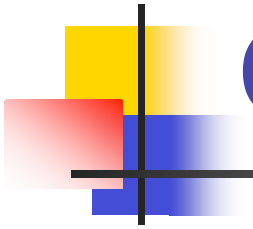
- No one claims they arose by chance.
- They are designed by intelligent (if malevolent) creators.
- How likely would it be for something as complex as a computer virus to arise by chance in the computer environment?

How Likely to Arise by Chance?



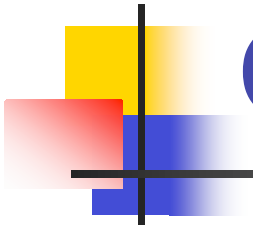
- Ludwig's "First International Virus Writing Contest" (1993)
  - Devise shortest virus possible.
  - Must have certain minimal functions.
- Ludwig gives a sample, the grand prize winner, and several runners-up.
- All are over 100 bytes in length.

How Likely to Arise by Chance?



- Shortest virus is 101 bytes
- There are 10^{243} possible files of length 101 bytes.
- If we have all 100 million PCs in world run full-time, making only 101-byte files at 1000/sec:
- Probability (hist univ) = 4×10^{-214}
- If every elementary particle in universe such a PC, then Probability = 6×10^{-100}

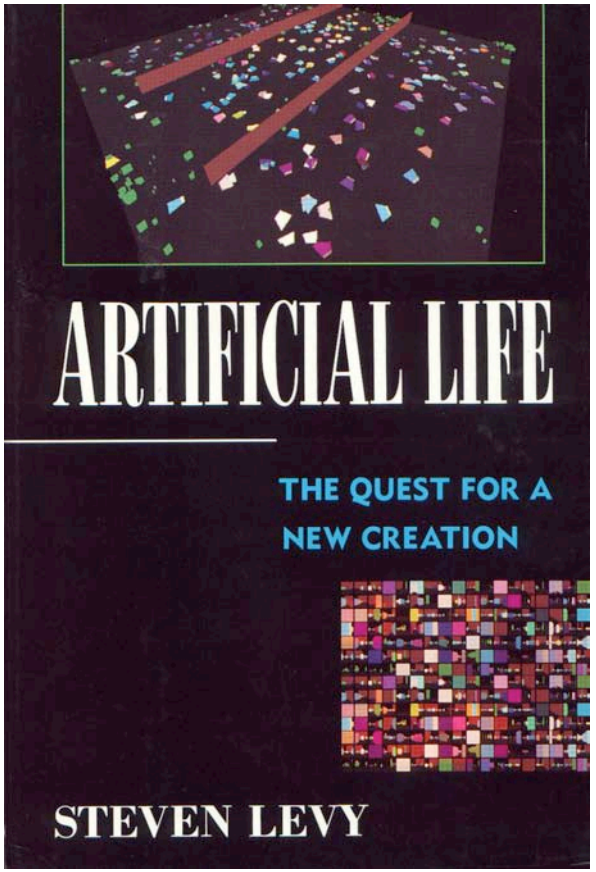
Summary on Computer Viruses

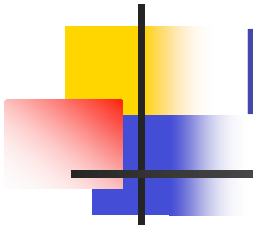


- Even very simple computer viruses are very complex from the viewpoint of random assembly.
- So we can see why no one thinks computer viruses formed by accident.
- But perhaps some other form of artificial life will show us how this could have happened.

Artificial Life

- What is artificial life?
- Attempts to mimic or reproduce life by human ingenuity.
- The term is commonly used today for attempts to mimic life by computer simulation, rather than by building up life from its basic biological components.

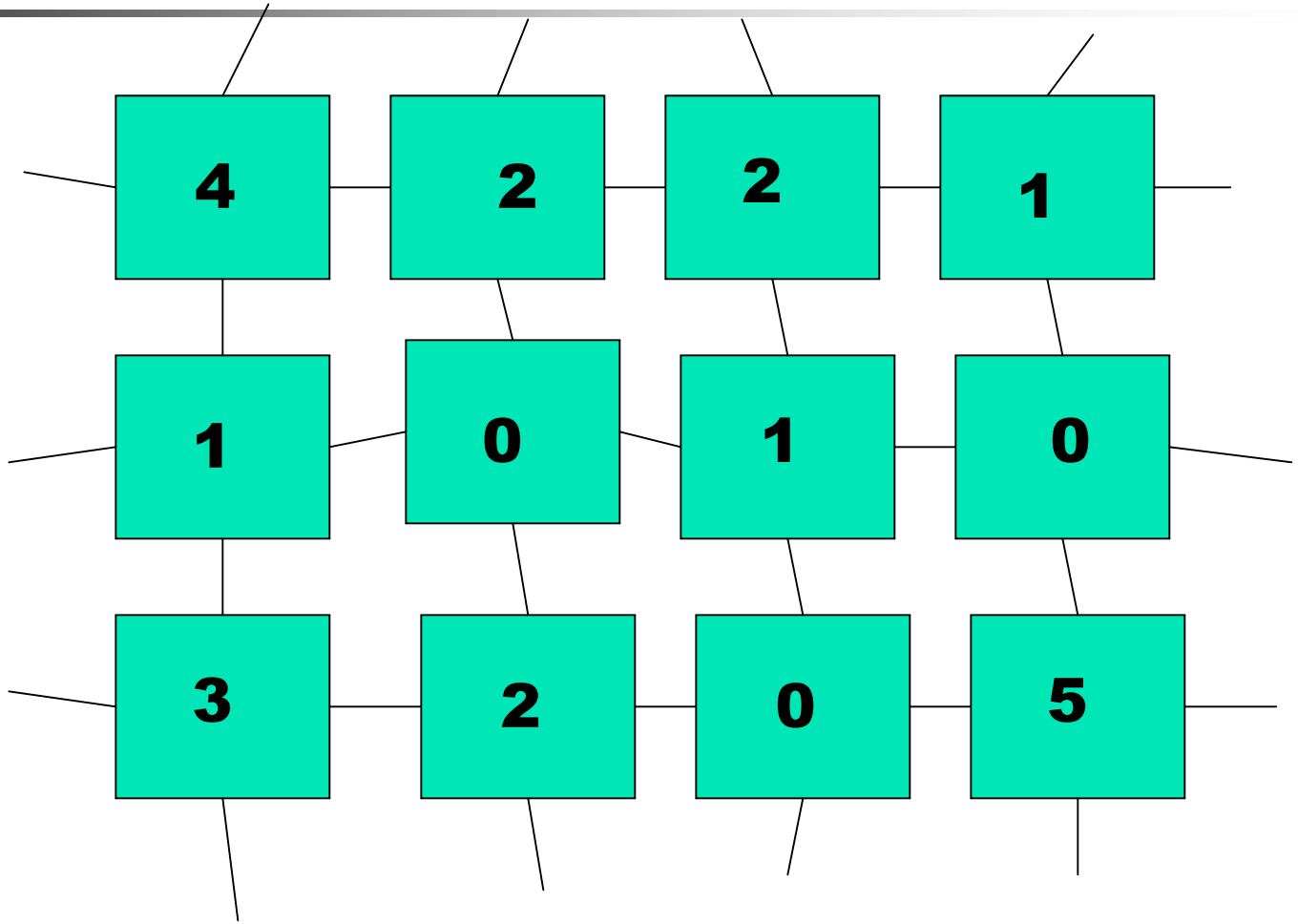




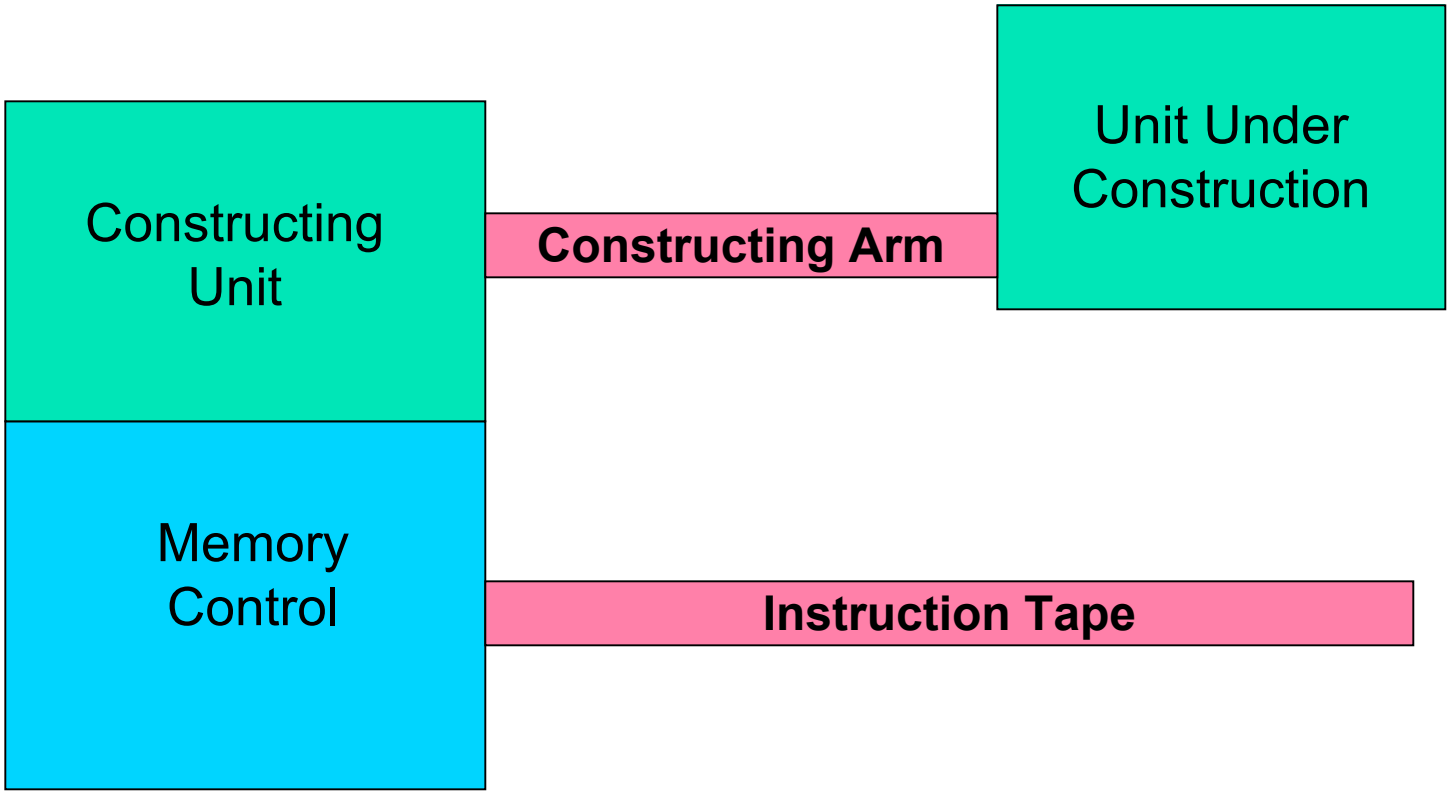
Making Artificial Life

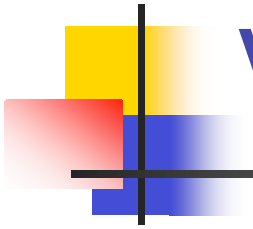
- Over 50 years ago, John von Neumann sought to design a self-reproducing automaton.
- He imagined a rectangular array of identical computer chips, each wired to four neighbors.
- Though identical, the chips will behave differently depending on what operational state each is in.

Von Neumann's Chips



Von Neumann's Automaton

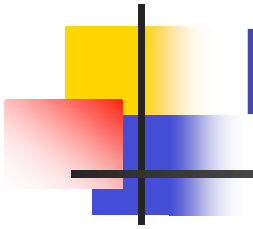




Von Neumann's Automaton

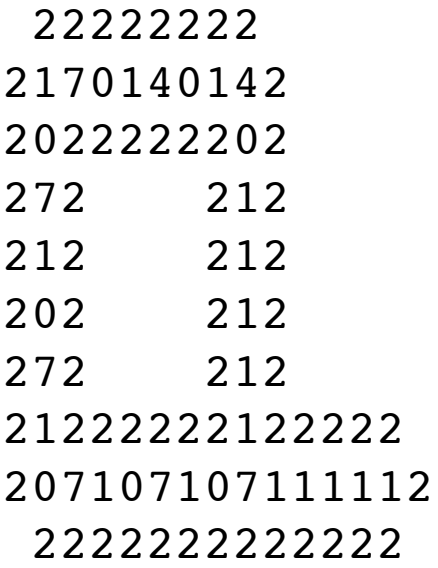
- Memory Control Unit – 300 x 500 chips
- Constructing Unit – 300 x 500 chips
- Instruction Tape – 150,000 chips
- Whole thing about as complicated as a modern computer!

Langton's Simple Automaton



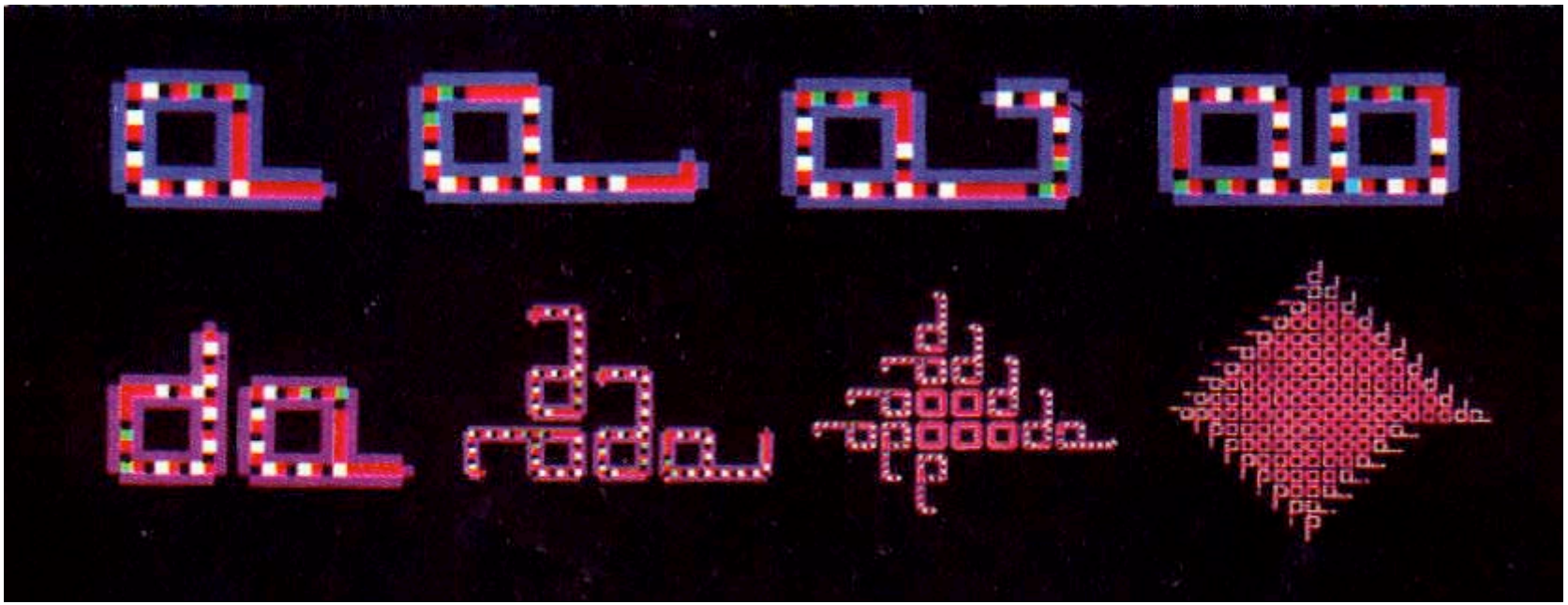
- Much simpler than von Neumann's
- Modified a small component part of a previous automaton so that it would reproduce itself
- A 10 x 10 loop with a 5 x 3 arm
- The "instruction tape" fits inside and extends arm by 6 units, turns left, repeats this 3 times, till arm collides with self, breaks off new loop and makes new arms for each.
- Reproduces in 151 time-steps

Langton's Simple Automaton

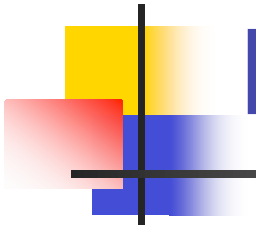


Langton's Simple Automaton

Bottom panel shows later generations:



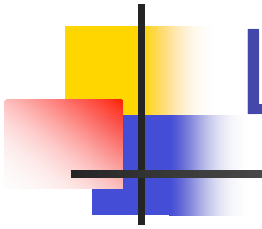
Byl's Simpler Automaton



```
T = 0     T = 5     T = 10
 22        22        22  3
2632      2342      2462
2642      266633    23664363
 25        2212      221222


T = 15      T = 20        T = 25
 22  3        22    2      22   22
2662   3     2632  362    2345 2632
243664362   264366432    2662 2642
 2212222     2212222      22 2 25
```

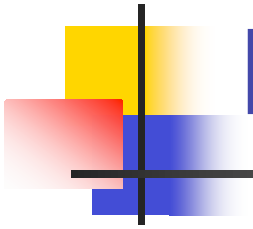
Ludwig's Simpler Automaton



T = 0	T = 1	T = 2	T = 3	T = 4	T = 5
2	2	2	2	2	25
212	212	212	21	213	21 4
	3	5	2	2	2
		4	636	626	2
			6	262	212

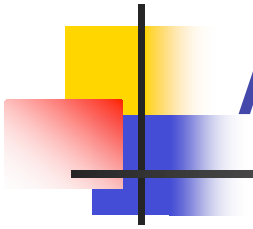
Probabilities for Random Formation

- Langton's Automaton
  - P (hist univ) = 1×10^{-129}
- Byl's Automaton
  - P (hist univ) = 1×10^{-69}
- Ludwig's Automaton
  - P(Byl assump) = 1 every 10^{-14} sec
  - P(more reasonable) = 1×10^{-86}



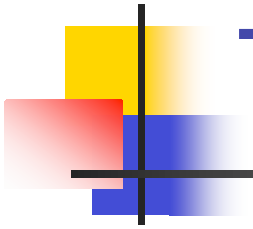
Problems w/ Simple Automata

- Not good for anything but reproduction.
- Reproduction typically collapses with any mutation.
- A viable automaton will need to be able to reproduce while changing.
- Thus need to add more chip states, increasing complexity



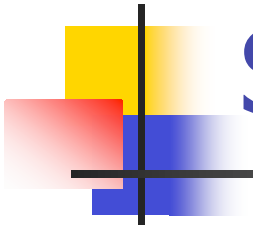
A "Life" Automaton

- Try to be more general than three above automata.
- Don’t tie to substrate especially designed for automaton.
- Use John Conway’s game “Life” as substrate.
- Simplest reproducer is enormously complex, like von Neumann’s!



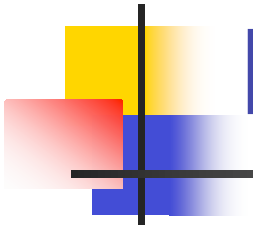
The Problem of Fragility

- All these automata run in an empty environment.
- What happens if they contact other objects in their space?
- Have tested Langton automaton for this; results are disastrous.
- Automaton is too fragile to function in such a space.



Summary on Automata

- Universal constructors far too complex.
- Special constructors too specialized, too fragile to handle mutations.
- Need to build automata that are:
  - general enough to be flexible,
  - are robust, and
  - not too complex to form randomly.
- This looks to be impossible.



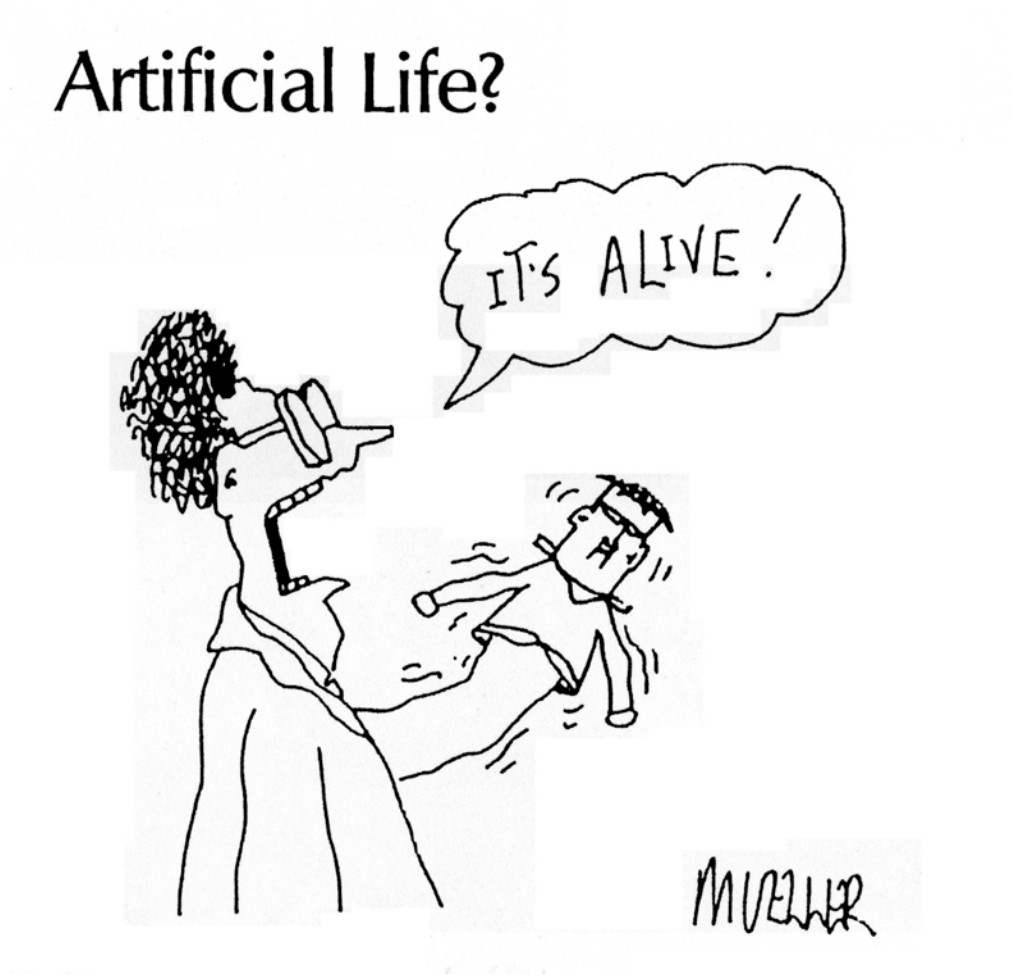
Real Life

- So far, the artificial life project is like the biological origin-of-life project.
- Both have produced some minor results, which have been hyped far out of proportion to their actual significance.
- Researchers realize you can’t get funding if the funders think the project is hopeless!

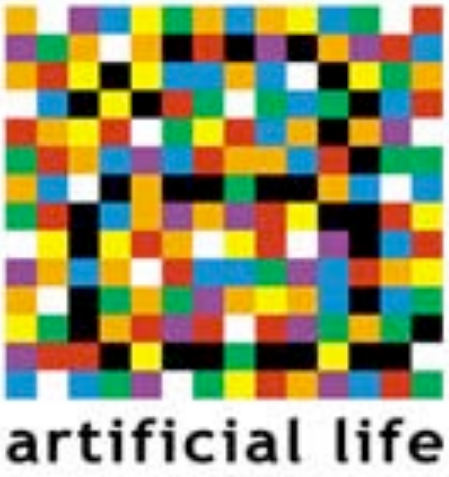
What This Means

- Don’t mistake research proposals for results!
- Don’t mistake worldview-driven visions for a view of the real world.
- The results look far more like evidence of intelligent design.

What This Means



The End …



Will man-made simulations prove life happened by itself?