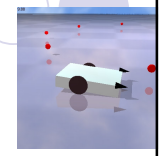
A-Life

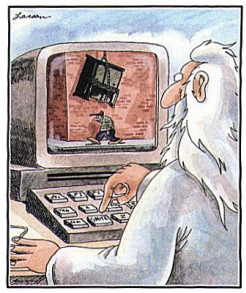
Yun Tao

Overview



- What it is
- History
- A Brief Case Study: Burtsev & Turchin
- The Controversy

The Philosophies

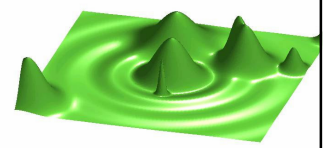


God at His computer

The Distinctions

Artificial Intelligence

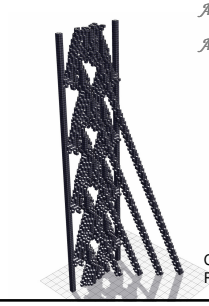
Evolutionary Algorithms



The Meaning

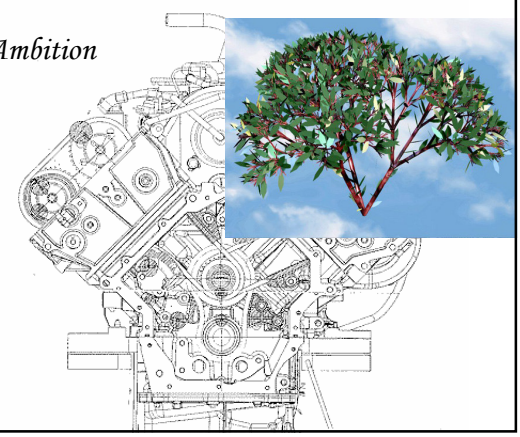
All living things a common nature own,

And thought erect an universal throne.



Conway's Game of Life in 3D Representation

The Ambition



The History

- ❖(40s) Von Neumann defines automaton
- ❖(60s) Conway from Cambridge produces the Game of Life
- ❖(70s) Langton creates the 1st self-replicating computer organism
- ❖(80s) Wolfram demonstrates the application of cellular automaton to natural phenomenon
- ❖(Now) Work is underway to create alife based on biochemical models

The Beginning

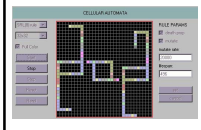
John Von Neumann

The Game of Life

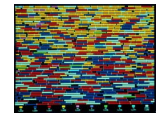
John Horton Conway

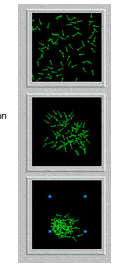
The Variations

Self-Reproducing Cellular Automata Loops



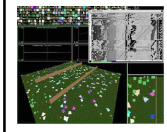
Tom Ray's Tierra



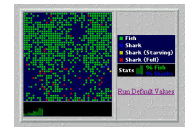


Sivermann's Composite of Swarm images

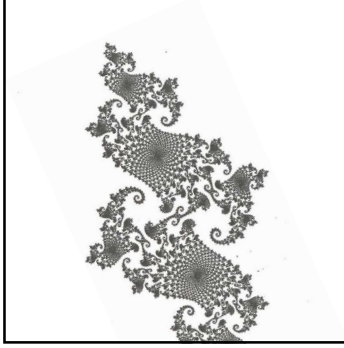
Polyworld



Planet Wa-Tor with its fish and sharks in competition

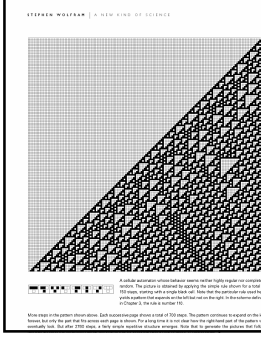


The Edge of Chaos



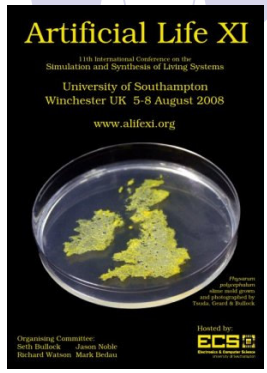
Christopher G. Langton

The New Kind of Science



The Modern Day

- Evolution in the Brain
- Open-Ended Evolution
- Artificial Consciousness: From Alife to Mind
- Communication in Embodies Agents
- Designing for Self-*
- Amorphous and Soft Robotics
- Dynamical Systems Analysis
- Trophic Interactions Between Digital Organism
- Autonomous Energy Management for Long Lived Robots
- Models for Gaia Theory
- Hidden Epistemology
- Synthetic Biology and Alife: A Potential Symbiosis
- Models of Microbial Evolution
- Alife in materio
- Spatial Organization
- Evolving Cell Signaling Networks in silico
- Major Evolutionary Transitions
- Sustainability



The Dove, the Hawk, & the Bourgeois

A Look at Evolution of Cooperative Strategies from First Principles

by Mikhail Burtsev & Peter Turchin

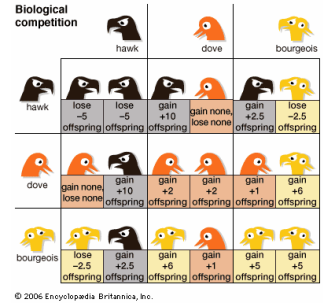
The 2-D Artificial World

The bourgeois

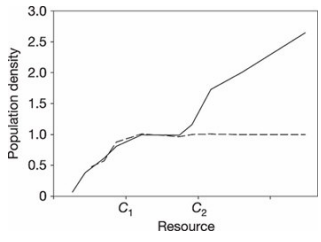
- Cells either contain a resource bundle or are empty
- Agents equipped with receptors, effectors and a neural net connecting them
- Sensory input
- External phenotype coded by markers
- Heredity and mutation
- Over $10^{1,000}$ potential behavioral strategies

The Objective

- To study how the presence of external markers influences the model's spectrum of evolving strategies
- To determine the effect of environmental carrying capacity on those strategies



The Marker-less Model



- Doves: never attack other agents and attempt to escape when attacked
- Hawks: make a living by predation on other agents
- Bourgeois: stay in the same cell and immediately attack any invader, while ignoring agents in neighboring cells

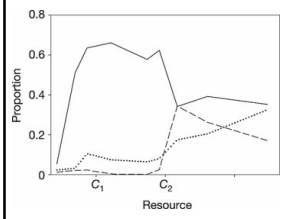
The Full Model

- Doves: ignored out-group members, but left cells with in-group members to avoid inter-specific competition

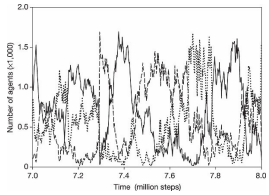
- Ravens: left cells with in-group members, but attack out-group members when detected them

- Starlings: stay in the same cell with in-group members and collectively fight with any out-group invader

The Emergence



Average proportion of agents using the raven (unbroken line), the cooperative dove (dashed line) and the starling (dotted line) strategies in the full model with markers as a function of the abundance of resources.



Numbers of agents using the raven (dashed line), the cooperative dove (dotted line) and the starling (unbroken line) strategies as a function of time in one realization of the model.

The End

"Sir, $\frac{a+b^n}{n} = x$, hence complexity exists—reply!"

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