

Artificial Life

Thumbing its Nose at Thermodynamics

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Questions

- Philosophy and Life - what is it?
- Can we say anything quantitative about it and describe behaviour in a way that distinguishes from non-life?
- Large and open area - how to carve off a do-able piece of work

Statistical Mechanics

- Physics/Statistics of agent ensembles
- Kauffman's speculations about a 4th law of thermodynamics
 - Cannot (?) pre-state phase space systems that include life?
 - How to formulate partition function Z when phase space is non-specifiable?
 - What is thermodynamics of agent ensemble?

Statistical Mechanics

- World of agents
- Each agent has a state - finite set?
- World therefore has a well-defined state?
- Ergodic hypothesis - each state of world equally likely - *a priori*
- *But world is NOT in equilibrium* - it cannot be - state space is too large for it to have explored all states in lifetime of the universe

The Meaning of Life

- How primitive does a world+agent system need to be before we can ascribe “life”
- What is “Life” ?
 - “A self reproducing information pattern”?
- So set up closed system (E conserving) of automata/CPG/FSM “agents”
- Traverse phase space

Laws of Thermodynamics

- 0 There exists a game (U)
- 1 Can never Win, only break even (T)
- 2 Can only break even at Absolute zero (S)
- 3 Can never reach Absolute zero

4? But Life “cheats” :-)

What does it mean cheating?

- Life systems are not necessarily in equilibrium - at some hierarchical level
- Entropy of closed system - with right definitions 2nd law still obeyed? (albeit system not in equilibrium - use external E to do work to create order)
- But Need a 4th law to explain or at least codify the effect where life systems change the rules and expand phase space in a non pre-determinable way

ALIFE Systems

- tierra (T.Ray)
- avida (C.Adami)
- Populations of self replicating programs (strings)
- Live in a simulated environment (eg square mesh)
- Interact, Live, Die, Evolve...

Hypotheses:

- Accept information definition of Life
- Accept that eg ants are in principle “agents”
- Accept T0, T1 as given
- Question ergodicity and T2
- Need for T4?

Programme of Work:

- Formulate closed system
- Evolve in time and average over phase space start points
- Observe order/disorder
- Entropy, Energy, Temperature, state variables...

Features for Exploration

- Geometry of environment (not just square mesh, but other topologies and dimensionalities)
- Agent approach to animat organisms and resources
- Hierarchy of primitives (primitives as well as simple instructions) - need hierarchical approach to the biology
- Chemistry and Physics? of ALIFE needed?

Notes - Issues

- Hardware, Wetware & Software
- Environment structure - Pin outs
- Fixed volume for cell growth?
- Multiple occupancy? FD/BE Stats?
- Finite size & Boundary effects
- Energy Conservation?
- Basis set of Life/DNA instructions?
- Dynamical hierarchies
- Agent programming approach
- Computational completeness
- Computational equivalence? (Wolfram)
- Comms and Short/Long range effects & locality

Summary

Animat Agent approach may give insights into:

- Artificial Life reductionist properties
- Statistical Mechanics & Physics of Agents

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