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The past, present, and future of artificial life

Article review

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Emergence of artificial life

- What makes the living different from the non-living?
  - Trend in mid-1980
  - Build life in order to understand it better
- This article reviews artificial life
  - Classified into 14 themes

The past

- Google for 'artificial life' in time (Ngram Viewer)
  - Frequency jumps between 1986-1997
  - High peek in 1821 – how?
    - Frankenstein
- Can we make living creatures? What are the conditions of life?
  - Creatures in mythology (Greek, Mayan, etc.)

The present
1. What is artificial life?

- Langton:
  - “life made by man rather than by nature,” - problematic definition
  - “artificial life” and “biology” should not differ
- Bedau:
  - interdisciplinary study of life and life-like processes
  - “Soft”: simulations
  - “Hard”: hardware
  - “Wet”: synthesizes living systems from biochemical substances
- ALife: currently it means artificial life

2. Origins of life

- Approaches
  - Metabolism-first (chemical change in cells)
  - Replicator-first
- (hen or egg)

3. Autonomy

- ~Self-maintenance
- In robotics
  - Move and interact
  - Without depending on remote control
- Degree of autonomy

4. Self-Organization

- Local interactions lead to global behaviors
  - Traffic, swarms
- Special cases:
  - Self-replication
  - Self-maintenance
  - Self-assembly
    - e.g. self-reconfigurating robots
- Recently
  - Cognitive science
  - Systems adapting to unforeseen circumstances

5. Adaptation

- Definition
  - A change
  - As a response
  - To fulfill goals
- Adaptation time scales
  - Low – evolution
  - Medium – development
  - Fast – learning

5.1 Evolution

- Genetic algorithms
  - Searches for a global minimum

5.2 Development

- Some computational models:
  - Neural networks
  - Bayesian networks

5.3 Learning

- No agreed definition
- Several approaches in machine learning
  - Neural networks
  - Reinforcement learning

6. Ecology

- Interactions
  - between individuals from different species
  - with their environment
- ALife ecological models:
  - Resource management
  - Land-use

7. Artificial Societies

- Interactions of individuals of the same species
- Topics:
  - Game theory: prisoner's dilemma
  - Evolution of language and communication

8. Behavior

- Sense-model-plan-act architecture
  - internal representations
- Adaptive behavior
  - contributions of the body and of the environment

9. Computational Biology

- ALife has contributed to theoretical biology with the development of computational models and tools

10. Artificial Chemistries

- Origin of life from chemical components

11. Information

- How the properties of living systems should be measured?
  - Adaptability
  - Autonomy
  - Complexity

12. Living Technology

- Technology that is based on the core features of living systems
- Primary: constructed from non-living components
- Secondary: depends on living properties
- Applications:
  - cleaning pollution
  - generating energy
  - improving health

13. Art

- ALife have been used for creating artwork
  - Visual arts
  - Music

14. Philosophy

- Is modeled life a real life?
  - “strong” and “weak” ALife
  - the objective results remain the same

The Future

- Many open questions
- Will ALife be considered as “artificial”?
- Movie: “Mechanical Love”