

Alife XII Panel Discussion, August 19, 2010

Which are the grand scientific challenges for the artificial life community?

Below we have re-printed the assessment of this question from 10 years ago, by Mark A. Bedau, John S. McCaskill, Norman H. Packard, Steen Rasmussen, Chris Adami, David G. Green, Takashi Ikegami, Kunihiko Kaneko and Thomas S. Ray.¹

Please think about the following:

- (i) Do we today, 10 years after, have answers to some of these open questions?
- (ii) Have the open questions changed over the last 10 years? If so, how?
- (iii) Do we have new open questions?

A. How does life arise from the nonliving?

1. Generate a molecular proto-organism in vitro.
2. Achieve the transition to life in an artificial chemistry in silico.
3. Determine whether fundamentally novel living organizations can exist.
4. Simulate a unicellular organism over its entire lifecycle.
5. Explain how rules and symbols are generated from physical dynamics in living systems.

B. What are the potentials and limits of living systems?

6. Determine what is inevitable in the open-ended evolution of life.
7. Determine minimal conditions for evolutionary transitions from specific to generic response systems.
8. Create a formal framework for synthesizing dynamical hierarchies at all scales.
9. Determine the predictability of evolutionary consequences of manipulating organisms and ecosystems.
10. Develop a theory of information processing, information flow, and information generation for evolving systems.

C. How is life related to mind, machines, and culture?

11. Demonstrate the emergence of intelligence and mind in an artificial living system.
12. Evaluate the influence of machines on the next major evolutionary transition of life.
13. Provide a quantitative model of the interplay between cultural and biological evolution.
14. Establish ethical principles for artificial life.

¹ At the 2000 Artificial Life conference in Portland OR, USA, we posed these same questions. See Bedau et al., *Artificial Life* Volume 6 (2000) 365