Artificial Life. As Artificial Intelligence is concerned with understanding rational thought through creating intelligent machines, so Artificial Life is concerned with understanding the principles underlying life, through synthesizing lifelike properties in computer simulations or in physical implementations. The motivation stretches back at least as far as the 1st Century AD, when Hero of Alexandria described working models of animals and humans, using hydraulics and pneumatics. From the Middle Ages on, technological developments in clockwork led to increasingly sophisticated automata that aroused admiration for their lifelike properties. In the late 20th Century, technological developments in computing allowed people to attempt to recreate different aspects of the properties of living organisms in simulations. The field of Artificial Life became identified under that name from a workshop organized by Chris Langton in Los Alamos in 1987, bringing together physicists, computer scientists, complexity theorists and biologists with a common interest in trying to understand the abstract principles behind the properties of life that might underlie not only carbon-based life as we know it on this planet, but also other possible life-forms elsewhere in the universe --- including potentially artificially created life-forms. A series of conferences and a journal form a focus for a loosely defined field distinguished by its interdisciplinarity.

Among computing pioneers with an interest in Artificial Life in the 1950s before the term was invented, Alan Turing modelled possible mechanisms for morphogenesis that could produce large-scale patterns through only short-scale local interactions. John von Neumann used Cellular Automata to describe how a (simulated) physical mechanism could replicate itself; in showing how this could be done with one part of the mechanism both directing the construction of a new version of the remainder and then being copied directly itself, he foreshadowed the later discovery of the role of DNA. Cellular Automata were later used by John Horton Conway for the

'Game of Life', where local interactions between neighbouring cells on a 2-dimensional lattice (displayable as black and white dots on a screen) can, with the appropriate update rules, lead to global phenomena such as 'gliders' travelling across the screen and interacting with each other. Artificial Life now includes the study of the origin of life, artificial chemistry, self-organization, morphogenesis, evolutionary and adaptive dynamics, robots and autonomous agents, computer viruses, communication and collective behaviour. Any aspect of living organisms, that differentiates them from lifeless matter, is a possible topic, from metabolism and self-repair to learning and behaviour. Also included are studies on the origin and evolution of language, though logic and rational thought would be considered to be traditionally the domain of Artificial Intelligence.

The different disciplines represented cover a range of motivations. Some theoretical biologists seek to understand real life using the new tools afforded by computer simulations, and new ideas from complexity theory. Computational neuroscience, and neuroethology - the relationship between brains and behaviour - are areas where use of computers has yielded new theoretical insights. In contrast, some computer scientists have the different goal of creating 'real artificial life' within a computer (artificial here meaning 'synthesized' rather than 'fake'); this leads to philosophical debates on just what is meant by such terms. There is a further different interest in Artificial Life that is application driven; designers of complex systems ranging from robots to telecommunication networks recognize that conventional designs have, so far, been lacking the robustness, the adaptivity and ability to self-repair that living systems have, and hope to learn practical lessons from this field. Examples where practical insights have resulted from Artificial Life approaches include the Sojourner Rover robot sent to Mars in 1997, based on ideas from Rodney Brooks' group at M.I.T.; evolutionary methods for optimising the design of aircraft

wings by British Aerospace and other manufacturers; the use of algorithms based on models of

ant behaviour for dynamic routing and load balancing by various telecommunication companies.

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