THE ALLURE OF MACHINIC LIFE

Cybernetics, Artificial Life, and the New AI

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Preface

This book explores a single topic: the creation of new forms of "machinic life" in cybernetics, artificial life (ALife), and artificial intelligence (AI). By *machinic life* I mean the forms of nascent life that have been made to emerge in and through technical interactions in human-constructed environments. Thus the webs of connection that sustain machinic life are material (or virtual) but not directly *of* the natural world. Although automata such as the eighteenth-century clockwork dolls and other figures can be seen as precursors, the first forms of machinic life appeared in the "lifelike" machines of the cyberneticists and in the early programs and robots of AI. Machinic life, unlike earlier mechanical forms, has a capacity to alter itself and to respond dynamically to changing situations.

More sophisticated forms of machinic life appear in the late 1980s and 1990s, with computer simulations of evolving digital organisms and the construction of mobile, autonomous robots. The emergence of ALife as a scientific discipline—which officially dates from the conference on "the synthesis and simulation of living systems" in 1987 organized by Christopher Langton—and the growing body of theoretical writings and new research initiatives devoted to autonomous agents, computer immune systems, artificial protocells, evolutionary robotics, and swarm systems have given the development of machinic life further momentum, solidity, and variety. These developments make it increasingly clear that while machinic life may have begun in the mimicking of the forms and processes of natural organic life, it has achieved a complexity and autonomy worthy of study in its own right. Indeed, this is my chief argument.

While excellent books and articles devoted to these topics abound, there has been no attempt to consider them within a single, overarching theoretical framework. The challenge is to do so while respecting the very significant historical, conceptual, scientific, and technical differences in this material and the diverse perspectives they give rise to. To meet this challenge I have tried to establish an inclusive vantage point that can be shared by specialized and general readers alike. At first view, there are obvious relations of precedence and influence in the distinctive histories of cybernetics, AI, and ALife. Without the groundbreaking discoveries and theoretical orientation of cybernetics, the sciences of AI and ALife would simply not have arisen and developed as they have. In both, moreover, the digital computer was an essential condition of possibility. Yet the development of the stored-program electronic computer was also contemporary with the birth of cybernetics and played multiple roles of instigation, example, and relay for many of its most important conceptualizations. Thus the centrality of the computer results in a complicated nexus of historical and conceptual relationships among these three fields of research.

But while the computer has been essential to the development of all three fields, its role in each has been different. For the cyberneticists the computer was first and foremost a physical device used primarily for calculation and control; yet because it could exist in a nearly infinite number of states, it also exhibited a new kind of complexity. Early AI would demarcate itself from cybernetics precisely in its highly abstract understanding of the computer as a symbol processor, whereas ALife would in turn distinguish itself from AI in the ways in which it would understand the role and function of computation. In contrast to the top-down computational hierarchy posited by AI in its effort to produce an intelligent machine or program, ALife started with a highly distributed population of computational machines, from which complex, lifelike behaviors could emerge.

These different understandings and uses of the computer demand a precise conceptualization. Accordingly, my concept of *computational assemblage* provides a means of pinpointing underlying differences of form and function. In this framework, every computational machine is conceived of as a material assemblage (a physical device) conjoined with a unique discourse that explains and justifies the machine's operation and purpose. More simply, a computational assemblage is comprised of both a machine and its associated discourse, which together determine how and why this machine does what it does. The concept of computational assemblage thus functions as a differentiator within a large set of family resemblances, in contrast to the general term *computer*, which is too vague for my purposes. As with my concept of machinic life, these family resemblances must be spelled out in detail. If computational assemblages comprise a larger unity, or indeed if forms of machinic life can be said to possess a larger unity, then in both cases they are unities-in-difference, which do not derive from any preestablished essence or ideal form. To the contrary, in actualizing new forms of computation and life, the machines and programs I describe constitute novel ramifications of an idea, not further doublings or repetitions of a prior essence.

This book is organized into three parts, which sketch conceptual histories of the three sciences. Since I am primarily concerned with how these sciences are both unified and differentiated in their productions of machinic life, my presentation is not strictly chronological. As I demonstrate, machinic life is fully comprehensible only in relation to new and developing notions of complexity, information processing, and dynamical systems theory, as well as theories of emergence and evolution; it thus necessarily crosses historical and disciplinary borderlines. The introduction traces my larger theoretical trajectory, focusing on key terms and the wider cultural context. Readers of N. Katherine Hayles, Manual DeLanda, Ansel Pearson, Paul Edwards, and Richard Doyle as well as books about Deleuzian philosophy, the posthuman, cyborgs, and cyberculture more generally will find that this trajectory passes over familiar ground. However, my perspective and purpose are distinctly different. For me, what remains uppermost is staying close to the objects at hand—the machines, programs, and processes that constitute machinic life. Before speculating about the cultural implications of these new kinds of life and intelligence, we need to know precisely how they come about and operate as well as how they are already changing.

In part I, I consider the cybernetic movement from three perspectives. Chapter 1 makes a case for the fundamental complexity of cybernetic machines as a new species of automata, existing both "in the metal and in the flesh," to use Norbert Wiener's expression, as built and theorized by Claude Shannon, Ross Ashby, John von Neumann, Grey Walter, Heinz von Foerster, and Valentino Braitenberg. Chapter 2 examines the "cybernetic subject" through the lens of French psychoanalyst Jacques Lacan and his participation (along with others, such as Noam Chomsky) in a new discourse network inaugurated by the confluence of cybernetics, information theory, and automata theory. The chapter concludes with a double view of the chess match between Gary Kasparov and Deep Blue, which suggests both the power and limits of classic AI. Chapter 3 extends the cybernetic perspective to what I call machinic philosophy, evident in Deleuze and Guattari's concept of the assemblage and its intersections with nonlinear dynamical systems (i.e., "chaos") theory. Here I develop more fully the concept of the computational assemblage, specifically in relation to Robert Shaw's "dripping faucet as a model chaotic system" and Jim Crutchfield's ϵ-machine (re)construction.

Part II focuses on the new science of ALife, beginning with John von Neumann's theory of self-reproducing automata and Christopher Langton's self-reproducing digital loops. Langton's theory of ALife as a new science based on computer simulations whose theoretical underpinnings combine information theory with dynamical systems theory is contrasted with Francisco Varela and Humberto Maturana's theory of autopoiesis, which leads to a consideration of both natural and artificial immune systems and computer viruses. Chapter 5 charts the history of ALife after Langton in relation to theories of evolution, emergence, and complex adaptive systems by examining a series of experiments carried out on various software platforms, including Thomas Ray's Tierra, John Holland's Echo, Christoph Adami's Avida, Andrew Pargellis's Amoeba, Tim Taylor's Cosmos, and Larry Yaeger's PolyWorld. The chapter concludes by considering the limits of the first phase of ALife research and the new research initiatives represented by "living computation" and attempts to create an artificial protocell.

Part III takes up the history of AI as a series of unfolding conceptual conflicts rather than a chronological narrative of achievements and failures. I first sketch out AI's familiar three-stage development, from symbolic AI as exemplified in Newel and Simon's physical symbol system hypothesis to the rebirth of the neural net approach in connectionism and parallel distributed processing and to the rejection of both by a "new AI" strongly influenced by ALife but concentrating on building autonomous mobile robots in the noisy physical world. At each of AI's historical stages, I suggest, there is a circling back to reclaim ground or a perspective rejected earlier—the biologically oriented neural net approach at stage two, cybernetics and embodiment at stage three. The decodings and recodings of the first two stages lead inevitably to philosophical clashes over AI's image of thought—symbol manipulation versus a stochastically emergent mentality—and the possibility of robotic consciousness. On the other hand, the behavior-based, subsumption-style approach to robotics that characterizes the new AI eventually has to renege on its earlier rejection of simulation when it commits to artificial evolution as a necessary method of development. Finally, in the concluding chapter, I indicate why further success in the building of intelligent machines will most likely be tied to progress in our understanding of how the human brain actually works, and describe recent examples of robotic self-modeling and communication.

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