Report on the ISAL Special Session on ALife and Society, ALife XV, Cancún, Mexico, 2016

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As part of the society-themed Artificial Life 2016 Conference, ISAL organized a special session on artificial life and its societal impact. This was a deliberate attempt to bring in new voices, to challenge ourselves as a community, and to start to build a movement within ALife to genuinely engage with society. Our motivation was a strong conviction that not only does our community have a responsibility to contribute to questioning societal trajectories and to shaping new approaches, but that we are uniquely positioned to do so. As yet our collective response has been fragmented and relatively underexplored. Our aim is to start the conversation, make connections, build a movement, and kick-start initiatives to engage with the future of society critically and creatively and forge the agenda for the way ahead. A diverse program of invited and contributed talks presented new perspectives on this broad theme. Speakers aimed to act as provocateurs, suggesting new approaches, highlighting challenges and opportunities, and asking key questions, sparking off group discussion, which continued throughout the conference with online collection of ideas and follow-up discussions throughout the week. This article gives an overview of the ideas and themes brought forward and where we might go from here.

1 Artificial, and Real, Life

The tone for the session was set with a forcible reality check from the invited speaker Luis Garcia Barrios, who has many years' experience of transdisciplinary participatory research with smallholders in the tropical mountains of Mexico. He asked us to consider what artificial life and complexity science offer the median human being, who, he reminded us, is working class and poor. He focused particularly on the rural poor, engaged in small-scale agriculture and hence intimately involved with the management of the complexity of living systems, yet marginalized by technological and societal change—people who are facing real, rather than artificial, suffering and death, in often brutal circumstances. With large-scale global economic and societal change, many rural communities of small farmers have seen their status diminish from stewardship of nature to a scrabbling, unstable existence begging at the edges of society. Interacting continuously with complex agroecosystems and intimately concerned with their dynamics, these farmers have an affinity for complexity-sensitive, ecosystemic approaches. However, although they have the potential to provide valuable ecosystem services, they are often forced into downward spirals of ecosystem degradation by the demands of the broader socioeconomic context. In parallel, the

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predominant visions of modern bio-smart farming (closed-loop hydroponic systems served by robots, for example) are of simplified, disconnected agroecosystems, which, although potentially resource-efficient, neither provide ecosystem services nor use human skill or labor. Luis discussed the alternative provided by agroecology, in which agricultural ecosystems are designed, constructed, and managed with the benefit of ecological science to provide both food and ecosystem services. Practitioners consider agroecology not simply a science, but a practice and a social movement—one to which artificial life could perhaps contribute.

Despite their inclination towards complexity-sensitive views and practice, there is still much that farmers and agroecologists could learn and assimilate from complexity science and artificial life. Luis and his group work directly with farmers, introducing them to fundamentals of complexity and ecological dynamics, through games, models, and participation. This provides them with the tools and knowledge to make better management decisions informed by up-to-date science, for their own socioecological systems. The sharing, testing, and co-producing of complexity insights and tools as they apply in the real world and impact peoples' lives is, he suggests, an area in which the ALife community could contribute substantially.

2 What Role for Artificial Life?

2.1 Models and Modeling Philosophy

At one step removed from the coalface of practice, other contributors suggested a diversity of potential roles that ALife could play.

Seth Bullock discussed the potential role of ALife's distinctive modeling approach within the science-policy interface [2]. Simulation is now widely used in policy analysis, but the ideal model is assumed to be one with (pseudo)empirical status, which can make detailed predictions or forecasts about how the impact of a policy will unfold. However, many policy domains are both complex and *theoretically insecure*: Well-established, broadly agreed-on theory does not yet exist for them. ALife-style exploratory models, designed to generate and advance new theory, might be more suited to such domains than misleadingly predictive models that rely on well-established theory. Given the urgency of the need to address complex system problems, Bullock argues that artificial life can function as a "model discipline" providing an exemplar of how exploratory models can be used to produce insights into the possible ways that systems *might* behave rather than simply predicting how they *will* behave. Exploratory models could be used to advance theory in policy-relevant domains, but can also be profoundly illuminating in their own right. A model providing an accessible narrative of how, for example, some plausible micro-level behavior might give rise to a counterintuitive higher-level effect could broaden understanding of how public policy could be made and the effects it might have. Developing and contributing to a science-policy interface, and indeed a policy process, that could make good use of exploratory modeling is a challenge that the ALife community could readily take up.

Simon Powers' models of the evolution of socioeconomic institutions provided an exemplar of this approach [4]. In modeling institutions as dynamic, evolving structures composed of and constructed by individuals—each of whom would prefer to construct rules that further their own self-interest—rather than as static, context-independent monoliths, we can provide a better understanding of how they really work. Models that acknowledge institutions as complex, evolving systems generated from the bottom up allow the exploration of potential nonlinear dynamics such as discontinuous change and allow us to interrogate how individual behavior and institutional forms might coevolve, potentially enhancing our ability to make effective policy. Although such simplified models are seldom used in policy arenas and could encounter strong criticism regarding their "practicality," they could potentially provide a crucial service in changing perceptions of what institutions and other social structures actually are or could be. Opening a window for policymakers to a perception of the components of the social and political world as dynamic and coevolutionary, capable of changing or being changed radically, could be powerfully influential.

2.2 Engineering Living and Lifelike Technologies

Other speakers discussed our role and responsibilities as engineers, considering the societal implications of the new, rapidly emerging technologies that we and others create. These include, amongst others, living and lifelike technologies, digital technologies, machine learning, and AI: the so-called BINC (bio, info, nano, cogno) technologies [5]. Enormous and potentially harmful change is arising from the way that these technologies are currently affecting society, culture, politics, economics, and the environment. There is an urgent requirement for new law, policy, and social norms to manage and adapt to these changes.

Steen Rasmussen presented numerous potential issues in the collaboratively produced BINC Manifesto [5]. A series of postulates on the current technological transition covering how the digital economy differs from the industrial, the citizen in cyberspace and as a biological entity, the erosion of the middle class and democracy in developed economies, and global interdependence of countries in the Anthropocene. Although these issues are becoming increasingly visible, particularly in the interaction of digital technologies with our democratic processes, social norms, and economies, his experience of policy engagement suggests that decision makers are as yet not open to fully addressing these changes. Again, this is a call to action for our community to consider and communicate the potential impacts of our technologies—impacts that may be increasingly felt under the pressures of increasing population, environmental degradation, and economic and political instability.

Exploring one such issue in detail, Dave Ackley discussed specific legal and social implications of one postulated future for ALife technologies, the "digital microbiome" [1], in which our personal devices might be host to myriad software-based artificial life creatures, potentially as vital to our normal functioning as gut bacteria. Ackley suggests that, as we potentially devolve more and more of our autonomic monitoring and processing to our devices, the boundary between the public and private network will become a point requiring legal definition. He argues that in such a situation regularly carried devices should be considered part of the self, rather than simply property, by both law and social norm. Such discussion highlights the need for hard thinking on these emerging issues, which call into question fundamental assumptions on the nature, rights, and responsibilities of the individual interacting in new technological and social contexts.

2.3 Society, Policy, and Economies as Complex Adaptive Systems

Contextualizing this discussion, Mark Bedau emphasized that the social, economic, and political contexts that new, living, complex adaptive systems (CAS) technologies will enter are also themselves complex adaptive systems. They thus have some of the same properties, and approaches to policymaking here must take account of the need to deal with these nested systems. Complex systems have particular properties that influence the way decisions, policymaking, and management for them should be properly approached. Bedau selects several key features of these "complex causal webs": They are composed of many nodes with nonlinear responses, with many local connections and loops, and with many up- and downstream connections. Altogether these properties mean that complex systems will display emergent properties and positive and negative feedbacks, and will be highly sensitive to their context. Their behavior cannot be precisely predicted; such systems are their own best model. The most effective ways to determine their future behaviors is via simulation, systematic experimentation, and observation as they unfold over time. Bedau suggests that this implies certain requirements for their effective management: "expecting the unexpected," due to lack of predictability; learning the nature of systems' global behaviors from experience, and remaining flexible as systems and contexts continually change; applying a plurality of approaches, methods, hypotheses, and experiments; and hence producing a diversity of perspectives. These requirements apply as much to how we should approach policymaking and management for the interaction of CAS technologies with society, as to management and design of CAS technologies themselves.

3 Reflections and the Way Ahead

Reflecting on the ALife and Society session, I believe that the diversity of perspectives and speakers and the enthusiasm and participation of the audience have shown us that there is a clear appetite for this effort within the community—and, I believe, has clearly demonstrated that we are in a position to contribute, through our tools, technologies, and philosophical approaches. We are at an apposite moment. Huge societal issues driven by technological, social, and environmental change now impinge on our daily lives and are common currency in the public domain, if not yet in mainstream politics. These issues have been visible on the horizon and the subject of discussion and work in complexity science and artificial life for several years. The problems have not changed, but only now have many of them entered into broad public discourse, often with a sense of apocalyptic urgency. The artificial life community has a great opportunity to contribute now, to offer our services, and to make our thinking as widely available as possible.

These problems are urgent and vitally important, and we have a responsibility to contribute, but also a great need to learn. My impression from some of the questions and discussion sessions was that there may still be an underlying tendency to consider these problems technical challenges to be solved or optimized. This is a dangerous fallacy. All the complex adaptive systems of societal concern require normative choices. Optimization must be for someone or something, and in these so-called "wicked problem" domains there are always tradeoffs, winners and losers, ethical judgments, and democratic decisions to be made. We should see ourselves and our work as the servants of society, not as its saviors. Although scientific expertise and technical contributions towards understanding and manipulating complex adaptive systems are clearly a large part of the puzzle, we must not make the mistake of underestimating the truly social, political, and practical nature of these issues. New political, economic, and social institutions are also needed to manage this emerging world, and the societal component of addressing these challenges requires participation and expertise from many quarters. We must engage in dialogue with the social sciences and humanities and be open to and respect diverse approaches and expertise. We must work collaboratively with stakeholders, from practitioners to communities, in real-world problem domains, merging theory and praxis. Engaging with people is both pragmatic and a serious moral responsibility.

We must focus attention on how our particular style of modeling can and should be used, providing a clear alternative to the idea of the model as an empirically valid stand-in for the system, with the model as an exploratory tool and probe of possible system behaviors. We must use models to provide insights into which kinds of low-level dynamics can give rise to which kinds of unexpected effect, emergent behavior or discontinuous, nonlinear change. Highlighting the need to take account of the possibility of complex, adaptive behavior leads to a requirement to change the form of the policy design, analysis, and evaluation processes. We must thus consider how theoretically insecure models can best fit within real decision making, design, and management processes and make the case for adaptive, flexible, and experimental decision making and policy frameworks that match the requirements of complex adaptive systems. Indeed, simply using simple, exploratory models to show decision makers what it could mean to consider a socioeconomic system a CAS and the radical difference that this might make would be a powerful achievement. Using models to provide transparent complexity narratives and bringing an understanding of the properties of complex adaptive systems into the public realm is one of the most important things that we could do to change the nature of the debate.

My final thought is that we should redraw the boundaries of what we consider to be artificial life (or the focus of artificial life), reconsidering what sort of systems we look at. We discussed the nature of living technologies, wet ALife, and synthetic biology as complex adaptive systems, but also the systemic complexity of the social, economic, and policy contexts, which themselves consist of many complex adaptive systems at multiple scales. I believe that we can usefully treat a great many human and socioecological systems as (hybrid) living systems and that many existing biologically-based technologies could be fruitfully considered artificial life in order to gain new insights and perspectives [3]. In contrast to synthetic biology, for example, artificial life can provide a non-reductive view of living technologies. Rather than representing the impoverished vision of the "bio-smart" future, epitomized by simplistic, highly controlled agroecosystems farmed by robots, I believe that artificial life more naturally connects to the nuanced, dynamic, interactive complexity of agroecology. The nature of ALife as a discipline concerned with the sprawling, evolving, self-creating, self-bounding, open, enactive, and embodied living system makes us the appropriate home for a new science, philosophy, and practice of managing, interacting with, creating, and steering rich, subtle, and ambiguously bounded complex adaptive living systems for society.

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