World Politics at the Edge of Chaos

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Chapter 5

Ascertaining the Normative Implications
of Complexity Thinking for Politics

Beyond Agent-Based Modeling

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Introduction

Central to representing the world as a complex dynamical system is understanding it as pertaining to an interdisciplinary approach to nonlinear processes of change in both nature and society. Although complexity research takes its origins from its applications in physics, chemistry, mathematics, and the “hard” sciences, undergoing its formative development in the 1970s, during the last two decades it has exerted an effect on the social sciences as well. Today complexity research is generating what Stuart Kauffman (2008, Preface) calls a “quiet revolution” in both the physical and social sciences.

One of the earliest centers for complexity research was at Santa Fe, where researchers developed the first research program with application to politics based on agent-based modeling. Research by Holland (1995; 1998), Jervis (1997), Axelrod (1997; 2006a; 2006b), Axelrod and Cohen (1999), Cederman (1997; 2001; 2003), Cioffi-Revilla (2002), Epstein (2007), Epstein and Axtell (1996), Hoffmann and Riley (2002), Moss and Edmonds (2005), Resnick (1994), Poundstone (1985), and many others was in the forefront of advances in the science of agent-based modeling and simulation. In politics and international relations research there was a marked growth of simulation modeling-type approaches (Bhavnani 2006; Bremer and Mihalka 1977; Bremer 1987; Bennett and Alker 1977; Hollist 1978; Plous 1987; Sandole 1999; Stoll 1985, Taber and Timpone 1996a, 1996b; Tritzsch 1997 to name just some of the more obvious). As defined by Cederman (2003, 138), “[a]
agent-based modelling is a computational methodology that allows scientists to create, analyze and experiment with, artificial worlds populated by agents that interact in non-trivial ways and that constitute their own environment.” Cederman termed his approach as complex adaptive systems’ (CAS) research, which constituted a variation on agent-based modelling, but within the broader tradition of agent-based research. It thus constitutes a programme that generates models that claim to represent reality in symbolic or numeric terms, where explanation and prediction are central aims.

I will argue in this chapter that what is distinctive about Complexity Thinking (CT) is largely missed by agent-based modeling approaches which confine research to a positivist-imitating style typical of the American environment in which it was developed. Its preoccupation with modeling, and the related concerns over prediction and validity, constitute the first set of major problems with the approach. These will be documented in the first part of this article. Of equal importance, to be explored in the second part of the article, the concern to emulate scientific standards has precluded any serious attention to politics in a normative sense, including a focus upon authority and institutionalization. Although recent debates within the agent-based modeling tradition, as well as the emergence of more empirically-minded ‘evidence-directed’ approaches (Alam, et al. 2007; Geller and Moss 2008; Bousquet, et al. 2009; Downing et al. 2000; Marks 2007) can be seen as efforts within the tradition to correct some of the problems I identify, such theoretical “soul-searching” only supports the thesis I offer and only goes a short way to remedy the problems to the extent that prediction is not a central issue.

In addition, I argue that the agent-based modeling approach to the complexity of global life has not only been constrained by the positivist nature of the general social science research habitus, especially in the USA, but it has largely ignored the broader theoretical contributions to CT centering on the work of Gilles Deleuze, Niklas Luhmann, and others, within the European theatre of scholarship. It is because it has confined itself within a scientific approach based on modeling that it eschews any normative role for politics, institutionalization, or the role of the state more generally. Drawing more from the philosophical and systems contributions to complexity, and from writings in physics of the Belgium Nobel prize winner, Ilya Prigogine, CT, I will suggest, opens possibilities toward a rich new conception of “complexity-based” historical materialism. Such a conception, I will argue, moves beyond the classical conception of Marxist historical materialism, which schematizes and periodizes according to fixed stages, and which notoriously prioritizes the economy as both primary determining force and explanatory constant, in order to advance a radically nominalist and non-teleological historical conception based upon the principles of “contextual contingency,” “time irrevers-
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ability,” “non-reductionism,” “self-organization,” and “emergence” (concepts which will be discussed below). The strength of this approach in relation to politics is that it permits a normative emphasis on institutionalisation and authority, which the American tradition of agent-based modeling has signally failed to develop. To advance this thesis I will firstly outline and criticise agent-based modeling approaches to complexity more specifically, and then, in the latter part of this article, proceed to outline the implications of complexity for politics that such an approach misses.

Agent-Based Modeling

An Introduction to the Approach

Agent-based models aim to construct models of how social institutions and values arise from a consideration of the interactions between individuals, ‘bottom-up,’ (so to speak). As the science writer Philip Ball (2004, 441) notes, “agent-based modelling should make some of the greatest social and political questions of our time accessible to rational experiment, such as whether the globalization of the economy is likely to lead to greater cultural harmony or cultural conflict.” A central pioneer of the approach was Robert Axelrod. For Axelrod (1997), building on the work of early exponents like Thomas Schelling and Herbert Simon, agent-based modeling is “a third way of doing science . . . which generates simulated data that can be analyzed inductively” (Axelrod 1997, 3–4). The approach became the core of what became known as the ‘artificial societies’ approach. As Axelrod states:

Unlike typical induction, the simulated data come from a rigorously specified set of rules rather than direct measurement of the real world. Whereas the purpose of induction is to find patterns in data and that of deduction is to find consequences of assumptions, the purpose of agent-based modelling is to aid intuition. Agent-based modelling is a way of doing thought experiments. (3–4)

Axelrod’s landscape theory, which was developed to predict alliances and aggregation patterns in political contexts, is a good example of the approach. As Axelrod (1997, 79) notes, the idea of “an abstract landscape has been widely used in the physical and natural sciences to characterize the dynamics of systems.” Its first rigorous development was in reference to Hamiltonian systems, and “biologists have independently developed landscapes to characterize evolutionary movement in an abstract ‘fitness landscape’ of genes (1997, 79). In
Axelrod’s hands, landscape modeling functions in the service of game theory. It “begins with sizes and pairwise propensities that are used to calculate the energy of each possible configuration” (1997, 79) in order to characterize “all possible configurations and the dynamics among them” (80). It is utilized “to make predictions about the dynamics of the system” (80) in relation to how actors will form alignments. Axelrod “retrospectively” conducts research to “predict” the alignment patterns of the Second World War in Europe. The question was, after the First World War, what caused the patterns of alliances? Axelrod fed key indicators into his computer model in order to predict the alliances. The information included such things as “the size of each country,” “a national capabilities index,” an “index of the degree of power held by each based on an index of military-industrial strength,” and so on. In that it gave a picture of the historical landscape, it was very much as a map of the possibilities, where a statistical profile of “likelihoods” or “possibilities” documents a map of the terrain of the future. Axelrod also develops other models, based on computer simulation, to do with such variables as promoting cooperation (Axelrod 1984), norms creation, the setting of standards in commercial contexts (1997, Chap. 5), or the creation of new political actors (1997, Chap. 6). It is indisputable in one sense that agent-based modeling constitutes a powerful tool which enables the exploration of relationships that are neither analytically nor empirically tractable. Such an approach can reveal new qualitative dimensions of processes and thus enables the exploration of multiple possible histories via repeated computer simulations. It can do this through simulating interactions within a systems context characterized by non-linearity, emergence and interconnectness, in a way that permits the computer manipulation of variables in changed contexts.

The Limitations of Agent-Based Modeling

Although complexity ideas apart from agent-based modeling have been variously introduced into politics and international relations research (Bousquet and Curtis 2011; Bousquet and Geyer 2011; Geller 2011; Geyer and Pickering 2011; Hoffmann and Riley 2002; Harrison 2006a, 2006b; Harrison and Singer 2006; Jervis 1997; Kavalski, 2007; Lehmann 2011; Ma 2007; Rosenau 1990; 2003) outside of the modeling approach complexity-based research is relatively embryonic as a form of analysis. In their recent article, Bousquet and Curtis (2011), make the point that agent-based modeling has been to date “the only area to have generated a coherent and cumulative research agenda” (44), but also claim that such an approach should not “exhaust the potential of complexity thinking” (44). From their perspective, it is important to look for ways that complexity can “extend important debates within IR,
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and draw out many of the connections between IR and complexity that have remained either implicit or overlooked” (44). What is needed is a conception of complexity that “goes beyond its metaphorical and modeling applications” (44). What they fail to do is specify precisely where the acknowledged deficiencies of modeling approaches reside, and conversely, where the distinctive importance of complexity for politics is to be found. It is these dual lacunae that the main thrust of this article will seek to address.

In earlier work on complexity and world politics, David Earnest and James Rosenau (2006) maintain that agent-based modeling methodology fails on two counts. Firstly, it fails to achieve the status of a theory, maintaining only that of a general perspective or paradigm. This is to do with the fact that its methods are neither inductive nor deductive, but based on simulation modeling through computational and mathematical approaches. Second, they claim that “it is unclear . . . that empirical tests of computer-simulated processes can in fact test our hypotheses about actual dynamic systems” (Earnest and Rosenau 2006, 149). Hence, there is a lack of isomorphism between model and reality.

Although, since they wrote, various “evidence-directed” research has sought to engage such criticisms, their basic claim that agent-based modeling methods typically employ assumptions about human rationality and other simplifications about everyday decision-making which constitute foundations to the system, still constitutes a problem with respect to both the validity of models, as well their ability to predict. One central problem is that humans do not follow simple static decision rules. Given that model construction depends necessarily upon a trade-off between parsimony and reality, it is difficult to see in a theoretical sense how a model could contain dynamic response capabilities that enabled it to respond to or account for the complexities of the world. As decisions in the world depend on who we are, and as our identities for complexity theories, are contingent assemblages (to use a Deleuzean concept), shaped by dynamic events in the system, it would seem not possible, as Earnest and Rosenau (2006, 150) put it, “to capture the adaptive behaviour of agents through genetic algorithms.” The writers they have in mind who do this include Holland (1995, 1998), Jervis (1997), Axelrod (1997, 2006a, 2006b), Axelrod and Cohen (1999) and Bhavnani (2006).

Whether it is strictly necessary, as Earnest and Rosenau claim, to reject complex adaptive systems research in toto, or whether simulation research based on “agency-level computational models” (Saunders-Newton 2006, 165) can not offer a “third leg” position (Marney and Tarbert 2000), yielding some useful knowledge, if nothing else, for different types of scenario planning, we do not need to dispute. Scenario forecasting is certainly useful, as is risk analysis generally, and the use of modeling can in these contexts be a useful
form of analysis. We can concede also that agent-based modeling can enable the exploration of certain relationships and possibilities through simulation methods that are not tractable by other means. We can concede further that newer “evidence-directed” approaches (Geller and Moss 2008) and lively discussions about model validation (Marks 2007) are also constructive. Insofar as approaches to model building eschew the goals of prediction and generalisation, but confine their purpose to exploration or clarification, they escape some of the general criticisms being made. Agent-based modeling may, then, provide, as Axtell and Epstein (1994) maintain, a powerful computer technique for gauging the general lie of the land, exploring multiple possible scenarios, manipulating variables or altering environments. However, it is problematic as a predictive methodology, and will be of limited value concerning issues of validity consistent with the general epistemological constraints of modeling construction in terms of a necessary trade-off in terms of parsimony and reality. Although the literature reveals growing awareness of these limitations today, this criticism is particularly appropriate against the more traditional ‘artificial societies’ form of agent-based modeling as developed and inspired by Axelrod’s research. This explains possibly, as Marks (2007, 281) notes, the relatively small uptake of the approach by many social scientists, including economists.

In addition to this, in that such a methodology depends on ahistorical genetic algorithms and simulation, a pernicious form of foundationalism is introduced into systems thinking. Such genetic algorithms cannot emulate the processes of how human beings make decisions because the very process of making decisions will be affected by system inputs and dynamics. Neither can behaviour or future actions be predicted from such models since system perturbations are, in theory, unpredictable in open environments. This, at one level, is accepted by Axelrod (1997), who justifies simulation as a method on the grounds that the emergent properties of such models cannot be deduced. In that it employs simulation:

it does not aim to provide an accurate representation of a particular empirical application. Instead, the goal of agent-based modeling is to enrich our understanding of fundamental processes that may appear in a variety of applications. This requires adhering to the KISS principle, which stands for the army slogan “keep it simple, stupid.” (Axelrod 1997, 4–5)

The difficulty is that keeping it simple doesn’t resolve the theoretical problems. Neither does making model building more complex by being more
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sensitive to empirical data in the construction of models. This is because what is crucial is not how accurate the model is in representing the past situation, but its theoretical inability, once formed, to ascertain dynamic events in either the present or the future. This is due to the complexity postulate of unpredictability and the general lack of isomorphism between model and reality with particular relation to dynamic events. The more recent ‘evidence-driven’ modelling tradition seems predicated upon the assumption that if models are empirically validated at the micro level they will exhibit macro validity as well, but this is not logically the case. Axelrod was at least aware that pursuing a more evidence-directed approach in relation to model construction and validity would not actually resolve the issues at stake.

The pivotal role of assumptions underpinning model formation is what must be appreciated here. By its very nature in providing predictions of the future, or even explaining real behaviour in the present, the technique trades on an elision between model and reality. In justifying his “landscape” modeling, Axelrod (1997, 88) claims that his theory “does very well in predicting the European alignment of the Second World War.” His prediction is “accurate for all but one of the seventeen countries” (it was not clear why the Western alliance did not oppose the Soviet Union rather than Germany), even a single “error” or “discrepancy” of this type presents a potentially serious headache for policy planners relying on such a technique. It is the same situation for the other models Axelrod develops, or for those writing later in the tradition. As Ball (2004, 361) notes, it is not clear that it is any more useful as an approach than simple realist assumptions based on self-interest and suspicion. It is only as a form of ‘retrospective prediction’ that such a technique functions, for in an open system that predicts from the present to the future, there is an important sense in which it can not know where to look, or what to look for, and what is more or less significant. While a model can contain provision for unpredictability, we can only evaluate the effectiveness of such models ability to predict in hindsight. Only retrospectively can we decide on what the critical or spinodal point was, in order to conclude that between 1936 and 1939 “history seems to pass through a kind of spinodal point where the anti-Soviet alliance ceases to be viable” (Ball 2004, 366). Axelrod’s landscape model, then, constitutes, as Ball (2004, 361) notes, citing Michael Oakeshott (1933, 128) a type of “counterfactual history” which claims to give us a picture of the historical landscape, but in fact provides only a retrospective “prediction” on history. It is noteworthy in this respect that Oakeshott opposed the method.

Furthermore, in what must appear as a positivist-style attempt to save a science of prediction in the face of complexity and non-linearity, there is
a sense in which agent-based modeling as developed by Axelrod, alongside later proponents of the approach, functions generally as a form of scientism. In this sense, agent-based modeling can be seen as an attempt to reinstate a policy science of reliable prediction (a dominant concern of the American science community) against the main argument or insight of the complexity revolution: that prediction is theoretically not possible. While, of course, events maintain a normal order of regularity which we may come to rely upon, what cannot be excluded is the occurrence of surprise events. If complexity physics asserts anything through its emphasis on non-linearity and stochastic emergence it is this: that it is not possible to predict macrobehaviors or collective actions simply as a scaled-up version of individual behavior or microevents. Complexity by definition is not additive! Furthermore, even within the micro or macro, trajectories are not deterministic or linear. Given these points, as Ball (2004, 441) notes, there is an ever-present danger that “any particular agent-based model of a social phenomenon risks coming to conclusions that depend on the underlying assumptions of the model.” Agent-based modeling depends on a prior specification of agent characteristics including genetic predispositions and static operational rules for engagement and interaction (as core features of the model). If simulation then proceeds in order to detect “properties that occur at the level of the whole society” (Ball 2004, 3) it thus contradicts the principle of non-additivity. In short, in that it seeks to generalise and predict, agent-based modeling seeks to ascertain what complexity declares impossible; viz. the impossibility of scalable measures of future or of macroorder behavior.

These criticisms are brought home forcefully by Thomas B. Pepinsky (2005) in his rigorous examination of the epistemological and ontological entailments of simulation modeling. Noting how simulation modeling aims to create “an artificial representation of a real world in order to manipulate and explore the properties of that system” (369), he notes how much knowledge and detailed information—concerning the “environment,” the “agent,” the “rules,” and the “parameters”—any model constructor who attempts to model microinteractions for assessing macrooutcomes must have. Comparing politics and international relations to a small case study of aerodynamics of lift, he notes how politics is a much less certain arena where full knowledge permitting model construction is highly unlikely to prevail. It is dubious in his view whether all of the relevant rules and parameters that could possibly affect behaviour in real life can be captured in a simulation. He could, of course, have gone even further than this, for in open environments as theorized by CT there is first, an epistemological problem, in Donald Rumsfeld’s sense, of knowing what one doesn’t know, or even worse, of not knowing what one doesn’t know. The model constructor can only construct
using the awareness of the situation as it is presently understood. The issue extends, second, to the problem articulated by Alan Turing and Alphonso Church many years ago, of the logical inability of predicting in open environments on the basis of any specified algorithmic specifications. Both Turing and Church demonstrated in mathematics that decisions and events in the future were always in excess of the algorithm that was established to predict them, and could not be predicted on the basis of such an algorithm. Kurt Gödel's 'incompleteness theorem' demonstrated essentially the same thing. (see Hodges 2000, 493–545; Mitchell 2009, 60–70).

Marks (2007) recent robust discussion of validity and prediction issues (which highlights many of the issues I am raising), is certainly positive. However, the net effect is to limit the applicable scope of agent-based modeling as an approach. Furthermore, his discussion does not deal with an even more serious omission in agent-based modeling approaches to complexity that I will identify. This is the absence of any plausible consideration of a normative role for politics, authority or institutionalization. These are issues I will take up below.

Toward a Richer Conception of Complexity and Politics

Those advancing agent-based modeling approaches have taken their inspiration largely from theoretical developments occurring the Santa Fe Institute for the study of complex systems, in New Mexico, USA. I argue that what is required is an elevation of the more historical approach centering on Prigogine and the Brussels School, as well as the European social philosophers like Gilles Deleuze (1987; 1990; 1994) and Niklas Luhmann (1995). While Deleuze has developed a philosophical approach that is consistent with CT formulations, Luhmann has adapted systems theory in the same way. Modeling approaches have, to date, colonized much of the significance of complexity analysis, seeking to adapt CT insights in accord with game-theoretic approaches to a modified but otherwise resurrected predictive scientific model. The result has been that a great deal of the real significance of the complexity revolution has been obscured.

I will argue below that it is toward a new historical form of systems thinking constitutive of a nominalist historical materialism that complexity directs us. Although historical materialism has traditionally been associated with Marxism, the classical stereotype of the economy as a determining foundation, as well as a lack of attention to other forms of power differentials (racism, sexism, etc) renders Marxism as problematic as a vehicle for comprehending systems complexity. Although Louis Althusser advanced
seminal insights in this regards, it is not within the scope of this paper to
discuss these further, except to say that in my view, he failed to establish
Marx himself as a complexity thinker. In the sense that complexity can be
described as a form of historical materialism, then, it is as a specifically
non-Marxist, nonfoundational systems approach, which, in the language of
CT, is characterized by “self-organization,” “time irreversibility,” “contextual
contingency,” and “discursive mediation,” concepts to be explained below. As
such, it reconceptualizes what we mean by science, altering both our episte-
mological and ontological frameworks in relation to the way we understand
and represent our world. The central importance for politics is that once the
complexity of global life is more properly understood as this new form of
systems thinking, it has implications for institutionalization, the role of the
state, and for global politics, of a kind wholly missed by the agent-based
modeling (mis)appropriation of the tradition.

If CT has a richer significance than that encapsulated in modeling
approaches, in what does it reside? At its most general level, as Frederick
Turner (1997, xii) points out, what complexity does is “place . . . within our
grasp a set of very powerful tools—concepts to think with.” Rather than
focus on prediction via simulation modeling, what complexity enables is
an approach that prioritizes axioms about indeterminacy; nonpredictability;
uncertainty; emergence; self-organization; contingency and historicity; lim-
ited or partial knowledge; mutuality; and insufficiency or interdependency
as basic postulates. What complexity physics has to offer politics is not new
models that enable prediction but new tools and axioms concerned with
how systems operate. It offers a way of understanding the role of struc-
tural factors in change, including nonpredictability and its consequences;
the delayed, unintended, or indirect effects of actions; and the importance
of “uncertainty,” “noise,” “accident,” and “emotion.” In introducing a systems
perspective into knowledge generation and research it qualifies the stark
individualism and reductionism of positivistic science as well as liberal philo-
sophical approaches. When systems effects are considered, it elucidates how
linear mechanical models frequently misrepresent the dynamics of events,
preventing a genuine understanding of outcomes.

CT asserts, in short, that linear models of science cannot reveal the
dynamics of complexity in systems. In addition, contextual contingency
defeats the possibility of laws of behavior or development of being decisive.
As with developments in fields such as thermodynamics, chemistry, biology,
and across the sciences, CT has shifted understanding of science (and the
world) in a way that also has application to the social sciences and politics.
From continental philosophy, also, among writers like Foucault, Deleuze,
and Luhmann, CT insights have assisted in resolving issues of determinism
and indeterminism, structure and agency, nature and nurture, system and part, as they have calamitously played out in the philosophies of writers like Marx and Hegel in relation to determinism.

Complexity as a New Form of Historical Materialism

In a range of publications from 1980s to 2004, Ilya Prigogine has developed a complexity formulation relevant to both the physical and social sciences. In works such as Order Out of Chaos (1984), written with Irene Stengers, and Exploring Complexity (1989), written with Grégoire Nicolis, it is claimed that CT offers a bold new and more accurate conception of science and the universe. This new conceptualization is superseding standard models, including quantum mechanics and relativity, which came to prominence at the beginning of the twentieth century as “corrections to classical mechanics” (Nicolis and Prigogine 1989, 5). Prigogine criticizes Newtonian mechanics and quantum theory, which represented time as reversible, meaning that it was irrelevant to the adequacy of laws. If a film can represent motion running backwards in the same way as running forwards, then it is said in physics that time is reversible. The rotation of the hands of a clock is reversible, whereas tearing a piece of paper is irreversible. Prigogine does not deny time reversibility but wishes to add that in many domains, including life itself, time is irreversible. CT builds on and intensifies the “temporal turn” introduced by this “correction.” Prigogine places central importance on time as real and irreversible. With Newton, say Prigogine and Stengers (1984), the universe is represented as closed and predictable. Its fundamental laws are deterministic and reversible. Temporality is held to be irrelevant to the truth and operation of the laws. As Prigogine and Stengers (1984, 11) say, “time . . . is reduced to a parameter, and future and past become equivalent.”

The Challenge to the Principle of Ergodicity

If time is irreversible, the future never simply repeats the past. Prigogine's revolution in response to the classical and quantum paradigms in formal terms was to challenge the principle of ergodicity which resulted in Poincaré recurrence. Restated by Henri Poincaré, the theorem expresses the cyclic time of the Stoics to formulate recurrence in an isolated system. This was the principle which held, in conformity with the law of the conservation of energy, that system interactions in physics would eventually reproduce a state or states almost identical to earlier initial states of the system at some point in the future. The amount of time taken for repeatability is known as
‘Poincaré cycle time.’ It was based on such an approach that time reversibility had been defined as real, and time irreversibility was an illusion. Prigogine challenged the relevance and applicability of these assumptions to classical or quantum measurement. If systems are never isolated or independent from their surroundings, then in theory, even small perturbations or changes in the surroundings could influence the system functioning or trajectory. Even very small perturbations could cause major changes.

As physicist Alastair Rae (2009) notes, “The consequences of this way of thinking are profound,” (113), for they replace assumptions of reversibility with irreversibility (114) and introduce notions of indeterminism into physics (113). Although quantum theory had introduced notions of indeterminacy, through the interaction with measurement, for Prigogine, such an indeterminism is more centrally associated with “strong mixing” in initial system interactions. ‘Strong mixing’ refers to the effect of influences or instabilities on a system, which are frequently chaotic, small or arbitrary. Another consequence explains how the individual subject can be both historically and socially constituted, yet unique. While each subject lacks an essence or substance (ousia), in Aristotle’s sense, ontological uniqueness is constituted in terms of differential affects of environment in relation to the different locations in space and through the differential affects exacted as a consequence of time irreversibility.

**Bifurcation and the Limitations of Prediction in Open Environments**

CT also defeats the possibility of historical inevitability and forecasting. In introducing a systems perspective, Prigogine’s innovation was to distinguish macroscopic from microscopic processes in explaining system behaviors, resulting in a different way of understanding order. Complex systems, in contrast to the classical mechanical and quantum models, are holistic in the sense that the whole is more than the sum of its parts, and where entities emerge from the interactions between part and part, and part(s) and whole. By defining order as a product of the system as a whole, as in a complex dynamical system, order or pattern associated with the macroscopic property of the entire system is not a property of the constituent elements of the system, yet can affect them through a variety of linear and nonlinear processes involving “feedback loops” or “endogeneity,” “strong mixing,” and “downward causation.” Prigogine’s contribution was to postulate that systems could also develop in states of nonequilibrium where, through a process of emergence, new features of the system develop in ways which are both practically and theoretically unpredictable.
When a system enters far-from-equilibrium conditions, its structure may be threatened, and a “critical condition,” or what Prigogine and Stengers call a “bifurcation point,” is entered. At the bifurcation point, system contingencies may operate to determine outcomes in a way not causally linked to previous linear path trajectories. Deleuze drew on writers like Prigogine in order to conceptualize indeterminacy at the level of philosophy. For Deleuze (1994), as Protevi (2006, 22) summarizes him, “a singularity in the [topological structure of the] manifold indicates a bifuricator.” The trajectory is not therefore seen as determined in one particular pathway. Although this is not to claim an absence of antecedent causes, it is to say, says Prigogine (1997, 5), that “nothing in the macroscopic equations justifies the preferences for any one solution.” Or, again, from Exploring Complexity, “[n]othing in the description of the experimental set up permits the observer to assign beforehand the state that will be chosen; only chance will decide, through the dynamics of fluctuations” (Nicolis and Prigogine 1989, 72). There is no way, even in theory, to tell what the future will be. Once the system “chooses,” it “becomes an historical object in the sense that its subsequent evolution depends on its critical choice” (72). In this description, they say, “we have succeeded in formulating, in abstract terms, the remarkable interplay of chance and constraint” (73). As such, “bifurcation is the source of innovation and diversification, since it endows the system with new solutions” (74).

Figure 5.1 offers a schematic diagram of bifurcation. Nicolis and Prigogine (1989, 73) make the following comment about the model:

A ball moves in a valley [a], which at a particular point λc becomes branched and leads to either of two valleys, branches b1 and b2 separated by a hill. Although it is too early for apologies and extrapolations... it is thought provoking to imagine for a moment that instead of the ball in Figure [1] we could have a dinosaur sitting there prior to the end of the Mesozoic era, or a group of our ancestors about to settle on either the ideographic or the symbolic mode of writing.

Although, due to system perturbations and fluctuations, it is impossible to precisely ascertain causes in advance, retrospectively, of course, we find the “cause” there in the events that lead up to an event, in the sense that we look backwards and point to plausible antecedent factors that contributed to its occurrence. While therefore not undetermined by prior causes, the dislocation of linear deterministic trajectories and the opening-up of alternative possible pathways that cannot be preascertained in open environ-
ments, is what Prigogine means by “chance.” In thermodynamics, Nicolis and Prigogine give the examples of thermal convection, the evolution of the universe itself, as well as climate and all physical processes. They were also aware, however, that their conclusions extended across all open systems to the social and human sciences as well, embracing life, all biological organisms, and social and political processes, as an illustration of nonequilibrium developments. Indeed, all systems (1984, 9) contain “essential elements of randomness and irreversibility.” In this context, the future is not simply unknown, but unknowable.

Self-organization, Emergence, Reduction and Contingency

For CT, there are no foundations or historical constants, such as self-interest, subject-centered reason, or economy, which guide politics. Therefore, predictability and political regulation are difficult, a fact that causes problems
for agent-based modeling approaches of the “artificial societies” type that Axelrod developed. Two key ideas of CT which reinforce these views include self-organization and emergence. The idea of self-organization entails that systems are not organized or regulated by anything external to themselves, in the sense of a foundation or essential principle that is ahistorical. This is not to say, of course, that complex systems do not organize themselves by drawing on external resources, such as energy and information. Also, although laws apply, they operate as a consequence of the elements within a system, i.e., relationally, and are contingent and evolutionary. This also explains how systems generate new patterns of activity through dynamic interactions over time. Of relevance to both self-organization and emergence, complexity theorists also typically represent the world as stratified, characterized by levels or sub-systems, interconnected by interactions. Within complex systems, the interconnectedness of part and whole means that interactions of various sorts will define relations at various levels. Interactions characterize relations, both at the microscopic (organisms, cellular life) and macroscopic levels. Such interactions can be of qualitatively different types, both linear and non-linear, and “multi-referential” in Edgar Morin’s sense. As he suggested, types of interactions that typify complex systems may be complementary or competitive, physical, biological, psycho-social, anthropological, economic, political, or so on. For Morin (1977/1992, 47):

Interactions (1) suppose elements, beings or material objects capable of encountering each other; (2) suppose conditions of encounter, that is to say agitation, turbulence, contrary fluxes, etc.; (3) obey determinations/constraints inherent to the nature of elements, objects or beings in encounter; (4) become in certain conditions interrelations (associations, linkages, combinations communications, etc.) that is to say give birth to phenomena of organization.

In relation to the concept of emergence, within any system, the macrostructure and microstructure of parts interact, affecting each other, and permitting indefinite recombination, thus ensuring new entities and structures, resulting in novelty and change (Capra 1996). It is through interactions at different magnitudes, which push a system beyond a threshold, that ontological emergence takes place, and it is this that defeats the possibilities of reductionism. Kauffman (2008, Chap. 3–5) states that there is “quiet rebellion” within science as to the adherence to reductionism. He notes various Nobel Laureates, such as Philp W. Anderson (1972), Robert Laughlan (2005), and Leonard Susskind (2006) who argue for emergentism and against reduction
to physical laws to explain life processes, or forms of social organization. Because relations and occurrences are contextual and contingent, it is not possible to predict macroproperties from a knowledge of the micro and vice versa. It also defeats the possibilities of universal laws as constituting a sufficient explanation for events—context is all. In this systems paradigm, the dynamic and non-linear assert themselves alongside the static and linear, and non-equilibrium and equilibrium operate as both temporary and intermittent.

Institutionalization and Complexity Management as the Basis of Normative Political Theory

If uncertainty and unpredictability are core complexity dimensions, then a strong normative role for political institutions would seem crucial. Yet, this is where agent-based modeling is most lacking. Extending their criticisms of the individualism of the approach, where political order is viewed as emerging solely from the interaction of agents, Earnest and Rosenau (2006) claim that it fails to be able to explain what is central to politics: authority. As they state:

The pattern of authority in [agent-based modeling] is one of its distinctive features: it has none. Authority is perfectly decentralized; each agent decides and acts on the basis of internal rules that evolve in response to environmental feedback. This is the logical antithesis of social authority, in which the privileged agent makes allocative decisions for a group of other actors. (Earnest and Rosenau 2006, 153)

The fact that agent-based modeling eschews any model of collective authority not only facilitates its possible uptake by political researchers of a more libertarian bias but is also clearly inadequate given the anarchic implications of complexity for societies and global politics unless accompanied by a normative emphasis on institutionalization and regulation. The absence of attention to authority can be discerned, in part because, as it developed initially in the North American environment, both agent-based (AB) and complex adaptive systems (CAS) simulation modeling approaches tended to be ontologically reductive, seeing order as emerging purely through the interaction of self-interested individuals. As Pepinsky (2005) puts it, this treats individual interaction “as ontologically prior to emergent properties of the system under investigation” (379). Further, he notes that researchers who employ simulation share the supposition “that the topology of the
environment will have no effect on the emergent phenomenon” (381). Such a reductionist tendency would be highly contentious within the broader confines of CT, which specifically emphasizes the effects of system on parts, as entailed in notions such as “downward causation.” In the work of writers such as Stuart Kauffman (2008), and more specifically in the European complexity tradition, the strong emphasis on nonreductionism entails an approach that is more systemic, where part and whole mutually affect each other and where emergence is an outcome of the system as a whole. Such an approach has a different entailment for representations of authority and politics. In this and the final section, I will maintain that, contra agent-based modeling, any adequate theory of complexity and politics requires a normative conception of authority and its institutionalization, if we are to forestall the possible drift to anarchy and catastrophe.

There is an overwhelming abundance of research that now documents that when the complexity of the world is unregulated it results in entropy and disorder, resulting in “power-law,” “non-scalable” distributions, productive of cumulatively unequal distributions in the social and economic world. ‘Power-law’ refers here to a statistical dynamic, but one which characterizes all areas of life—physical, biological, social, economic, political. Such power-law distributions were noted by Vilfredo Pareto in the last decade of the nineteenth century, with respect to wealth and authority. Here, unregulated contexts resulted in cumulative inequality, disadvantage, elitism, and étatism, based as they are upon inverse relationships between the numbers of people in the population and the amount of wealth or influence they hold. Power-law distributions are seen to be a function of what complexity researchers term self-organized criticality (SOC). They allow for extreme events and are indeed a pervasive feature of life and cancel out the significance of “average” behavior in Gaussian terms. As Ball (2004, 299) notes, “‘self-organised criticality is one of the few genuinely new discoveries to have been made in statistical physics over the past two decades, and it has proved an astonishingly fertile idea” (see Bak 1997, 191; Bak, Chen and Creutz 1989; Bak and Chen 1991; Buchanan 2000; Cederman 1997, 2003; Ball 2004, 297–300). Ball (p. 300) says it “seems to provide a powerful framework for understanding a wide range of phenomena.” Linked to self-organized criticality, power-laws entail ideas of non-scalability or additivity, due to nonlinearity of relations between micro and macro order phenomena, as well as unpredictability, because change can occur due to minor actions, or actions from a distance (see Bak 1997, 191). According to Ball (p. 498) “‘scale-free networks [which result in power-law distributions] are now starting to look like such a fundamental aspect of human culture that eyebrows are raised and questions asked when they do not appear.” Not only
does this apply to earthquakes, where “probability . . . diminishes as its size increases according to a power-law,” but it also adequately characterizes many social or economic phenomena, if unregulated through political action, as well. This has especially occurred with regards to economic inequality during the era of neoliberal govermentality. According to Ball (p. 307), in the USA in 2006 some 40% of the wealth was now owned by 1% of the population. Wealth inequality thus conforms to a power-law distribution unless regulated, as does leadership and power. That power-law distributions emerge in social life, introducing potential disorder, also creates an imperative of planning was noted by Richardson (1960) and Zipf (1965).

Given CT’s emphasis on unpredictability, uncertainty, and nonscalability, the role for politics is clearly an essential one of managing, containing, or even (in certain circumstances) permitting complexity. Because complexity gives us understandings about the unpredictable and interdependent nature of the world, politics and authority become the art, therefore, of complexity management. As Neil Harrison (2006c, 188) notes, politics in this sense becomes conceptualized as “the process by which the institutions governing collective behaviour are organised.” More recently, a similar point has been reinforced by Ma (2007) who argues that theories of institutionalized politics are premised on CT formulations of the world. In this sense, from the point of view of politics, we must conceptualize authority as normatively indispensible to a complexity approach, because, as Harrison (2006c, 188) puts it, “authority operates through formal and informal institutions. Informal institutions, like cultural practices, are shared meanings and emerge from agent interactions mediated through prior states of such institutions.” CT thus gives us a representation of the world which saves agency and choice as well as accident and error and which necessitates that it be managed.

Following from this, a number of additional but related insights regarding political management are generated by complexity. Because of uncertainty and the inability to predict accurately in open environments, politics can plausibly be represented inter alia as the art of managing the unexpected. This would suggest a positive role for the state, an argument which is strengthened by the fallibility of humans and the limitations of human reason in response to the complexity of environments. In that these are true, complexity mitigates against the individualism of the classical liberal tradition from Locke onwards, for individuals are conceptualized as insufficient and dependent upon other people and upon the systems and structures of social support. Such an approach has enormous implications for an ethics of action in world affairs, especially in regards to issues such as conscience, responsibility, and accountability in situations where prediction and control are elusive. My focus here, however, must be confined to the political and
to the implications of complexity for authority in both national and global contexts. Because complexity places emphasis upon each individual’s insufficiency in the face of a precarious and unpredictable environment, the normative implication for politics is not an antipathy to state and global structures, but rather an institutional-regulative approach to politics in general. Of possible assistance here is the approach described in the late nineteenth and early twentieth centuries by the welfare state liberals, from Mill to Keynes, including Green, Hobhouse, Hobson, Ritchie, and James Seth, which, as we face a precarious and uncertain future, might be profitably adapted, also, to new global contexts and conditions.

Such a politics also suggests a conception of social justice similar to that exemplified in the writings of David Hume. Hume can help us to understand how learning the arts of coordination can be understood. In part 2 of book 3 of the *Treatise on Human Nature*, Hume notes how justice is an “artificial virtue” (1978, 484). For Hume, justice is a coordinative virtue arising from insecurities about the possession of transferable goods. As Baier (1991, 228) notes, “Hume’s justice-inventors know from prior experience that cooperation and mutual trust are both possible and advantageous.” It constitutes for Hume a “will to cooperation, [which] by its very expression and replication, becomes the fact of cooperation.”

Institutionalization, then, is a normative consequence of the complexity of global life where the future is precarious, dangerous, and uncertain. It is through institutions that complexity is managed and by which the present is channeled to the future. If coordination is the institutional requirement of life’s *continuance*, that is, for survival and well-being, then democracy can be represented as a viable institutional mechanism for best enabling it. Indeed, contra agent-based modeling approaches, we can say that it is because of complexity that politics, institutionalization and democracy become necessary.

**Toward Global Cooperation**

If complexity requires institutionalization and an active state, the thesis can be extended to a consideration of Axelrod’s (1984; 1997) thesis on cooperation. Formulated in terms of Axelrod’s tit for tat model, currently the dominant approach to cooperation on offer, such an approach seeks to extend the assumptions of agent-based modeling in order to explain cooperation as resulting purely through the interactions between agents without any collective/institutional structures. This illustrates Earnest and Rosenau’s point above, that agent-based modeling allows for no positive conception of political authority. I, too, will argue in this section, that Axelrod’s tit for tat model
is deficient, and argue for what I will call an objective ethic (OE) approach to cooperation. This is based on early-twentieth-century economists associated with the welfare state, as well as by recent work of my own (Olssen 2008; 2010). These works contend that the normative implication of CT supports institutionalization and a regulatory role for the state.

Axelrod’s tit for tat strategy is premised on an iterated model of the prisoner’s dilemma, where the prohibition on communication is overcome through repeated plays of the game. The original Prisoner’s Dilemma accords to a Hobbesian-type pessimism whereby rational egoists will seek always to exploit each other. In the model, players do not (and cannot) communicate, the environment is inert, and only self-interest orientates behavior. In an iterated prisoner’s dilemma game cooperation can evolve if the players can learn from their mistakes to consolidate relations of mutual trust. Axelrod invited people to submit possible strategies to his prisoner’s dilemma in 1970, and Anatol Rapaport submitted the winning entry by suggesting that one begins by cooperating and then “echoes” one’s “opponent’s” moves. A great deal of store is placed, in the first instance, on cooperating. But, according to Ball (2004, 527), such a strategy would quickly fail, prompted by mistakes and misunderstandings, which would intensify in a capitalist market economy characterized by individualism and low-level paranoia as a generalized background habitus. Ball summarizes the critical literature concerned with Axelrod’s theory asserting that “there is in fact no best way to play” (529) and noting that tit for tat is an “eye for an eye” rather than a “turn the other cheek” morality (529). As Ball extrapolates, if a mistake is made, then players “get locked into a cycle of mutual recrimination” (540–41). Ball notes that Axelrod agrees with the observation (541) that feuding societies, like Albania, the Middle East, or Northern Ireland are relatively common. Ball also refers to Stanley Kubrick’s film Dr Strangelove, where through a succession of “errors,” Armageddon ensues (541). By itself, “Tit For Tat does not guarantee a harmonious world” (541). What transpires in all of the criticisms and all of the revisions of Tit For Tat is that “nice” strategies do better than nasty ones.

It is not clear how Axelrod’s tit for tat strategy, as a mechanism for cooperation, can work purely on the basis of interaction between agents, in the absence of authority or a positive-regulatory form of institutionalization. If I cooperate when you cooperate and defect when you defect, many have suggested that the world will very quickly be a “war of all against all.” Axelrod’s conception presumes a Nash-equilibrium where cooperation emerges purely through the interaction between agents and which presumes no supraindividual structures of authority as such. A set of strategies is a
Nash equilibrium if it constitutes the best set of responses in relation to all other strategies. ‘Best’ is defined as those strategies that succeed in market terms or, in other words, through the uncoordinated interaction of individuals. Such a theory would well suit those with a libertarian politics, as I observed above. While such game theoretic approaches are taken seriously by elite policy makers, it is difficult to see how such individualistic strategies could resolve the “tragedy of the commons” or promote cooperation in a global age. Many economists, including Keynes, Kalecki, and Hobson, disputed the equilibrium hypothesis. The ‘tragedy of the commons’ may well be exacerbated also by climate change, population growth, or the threat of nuclear terrorism, which would increase the requirement for authority.

This raises the question as to whether a game-theoretic approach based on self-interest is appropriate to explaining cooperation. The challenge I am interested in maintaining here is that “niceness,” i.e., cooperation, cannot theoretically be explained as emerging simply through the interaction between agents! What is required for explanation is a positive theory of institutionalization, a positive role for the state, and an objective ethic at both state and global levels. And this is precisely what Axelrod, and agent-based modeling in general, has shown no interest in providing. Indeed, this criticism applies to the entire tradition of simulation modelling to date, including agent-based approaches, but also to closely related complex adaptive systems approaches.

If, in a complex world, we are to account for “niceness” and maximize the possibilities for cooperation in the absence of a theory of equilibrium as the basis of order, then (a) the creation of intermediary institutions, (b) an objective ethic (OE) based on a conception of justice and democracy, and (c) a system of punishment related to this which constrains and rewards defectors are necessary. An OE approach could explain the inclusion of “niceness,” or “generosity,” because it would be concerned first and foremost with the positive normative content of what enabled people to live and develop their lives into the future under conditions of dignity and mutual respect, with the best likelihood of success for all. Such an ethic of cooperation can be justified as demanded by complex systems analysis if the project of humanity is to survive in order to avert any tendencies to disorder and entropy. Such an OE could be adapted to Nowak and May’s (1992; 1993) insights about the effects of space on cooperation, by adjusting the “rules” and “norms” according to the contingent circumstances of time and place. Two further concepts could augment this development: models of “Generous Tit For Tat” as developed by Nowak and Sigmund (1992) (in a critical response to Axelrod), and Fehr and Gächter’s (2002) idea of “altruistic punishment” (where they note that the threat of punishment increases cooperation). Punishment, as they use
the term, performs an adjunct societal function in keeping the project of humanity on track by appealing to each person and each community to exercise self-restraint. It is a constructed ethic for a complex world which permits life to continue into the future. Philosophically, it is based upon a theory of becoming. Politically, it depends on a theory of positive democratic state and global authority. It is the kind of normative politics demanded by complexity, but which agent-based modeling scientific approaches do not provide. For if the complexity revolution dictates anything it is that, more today than at any time previously, national and global institutions constitute preconditions for individual well-being, freedom, development, and survival.

Conclusion

In this chapter I have critiqued agent-based modeling as a pertinent approach to grasping the complexity of global life. There are several reasons for such critique. First, it has failed to appreciate or acknowledge the serious epistemological limitations of algorithmic modeling for either prediction or exploration for any purposes other than exploratory or heuristic intent. Second, as a consequence of its prior ontological focus on individual agents and their interactions, it fails to theorize systems adequately or to advocate and develop a necessary normative role for politics and institutions. Because it relies solely upon the interactions between agents, assuming equilibrium in nature, it fails to see how complexity requires a positive theory of state power and institutionalization as a “hedge” against anarchy, uneven development, or disorder. When extended, such a claim also undermines Axelrod’s theory of cooperation.

Such omissions in turn suggest that agent-based simulation-modeling traditions have a philosophically naive conception of complexity. To some extent I view this as a consequence of the fact that many of the early proponents were a part of the North American social science research environment, where a strong priority was given to positivistic norms and measurement quantification, as part of a reductionist scientific approach to understanding the world. While complexity was taken on board as a general social science approach, the general appropriation of the paradigm as developed by the likes of Axelrod and others lacked the philosophical coherence and rigor as it was developed by the early formulators of the approach, at Santa Fe by the likes of Kauffman, or in Europe by scientists such as Prigogine or philosophers such as Deleuze. Failure to understand the limitations of algorithmic modeling for prediction were only one aspect of this. To be so concerned
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with advocating a science of prediction, or with overcoming obstacles to prediction, given this was what CT announced as theoretically problematic, was yet another. Methods of prediction based on algorithmic models were developed and pursued, despite the important complexity insights of writers like Gödel, Turing, Church, and Wittgenstein, the significance of whose work is clearly not understood as complexity insights were appropriated for social science purposes. Although laws speak to important regularities, they cannot be certainties, and it is theoretically not possible to ascertain when a perturbation will derail a regular linear sequence of events. While such a postulate was theoretically applicable to all scientific prediction, in practice it is likely to apply more to the social as opposed to the physical sciences. And it is likely to be especially relevant to the messy worlds of politics and international relations.

Closely associated with modeling, we have noted other ontological shortcomings as well. In prioritizing agents and interactions, the simulation modelers’ render structural features such as “system” and “environment” as ontologically secondary or derivative, failing to fully understand the entailments of non-reductionism, thereby marginalizing the importance of system affects, downward causation, part-whole interactions and coevolution. Under the influence of Axelrod, also, various “metaphysical” elements, already prominent in North American empirical social science disciplines, become secreted within the version of complexity articulated. Hence, ideas of “economic equilibrium,” replete with metaphysical axioms concerning “self-interested egoism” (on which Axelrod’s idea of equilibrium depends) become operative as the basis upon which cooperation occurs and become the mysterious largely unexplained “metaphysical” source by which interactions between agents can result in order. There is, then, within simulation modeling approaches an insufficiently rigorous understanding of the epistemological and ontological commitments that a coherent doctrine of complexity entails, especially with reference to the historically contingent character of systems and parts, as expressed through concepts such as coevolution, emergence, nonreductionism, downward causation, and the necessarily historically contingent interaction between system and parts. Agent-based modeling approaches have therefore retained metaphysical “deposits” of various sorts, failing to comprehend the full ontological significance of complexity, as given both scientific and philosophical coherence by writers like Prigogine and Deleuze.

This chapter also highlights, at a somewhat more general level, the importance of CT as a new and different ontological orientation to politics, international relations, and political theory. As such, it offers a new
conception of the world which leads us to a different understanding of the possibilities and pitfalls for human collectivities as they seek to negotiate and realize a future. Such a new ontology suggests an approach broadly compatible with Heidegger’s notion of Abgrund, or groundless ground. It is in this sense “postmetaphysical” in that it seeks to self-consciously restrict its formulations within the finitude of the phenomenal making no claims about the noumenal character of the world in-itself. In abandoning the world of the in-itself—concerning God, determinism, causality, soul, self-interested egoism, and so on—one does not fall back into relativism and disorder, but asserts postulates which make sense at the level of our shared sensations and experiences oriented to a future geared to survival and well-being of life itself in terms of a theory of becoming. In addition to rejecting all traditional metaphysical foundations, by way of essences or substances, a complexity approach reestablishes a holistic and nonreductionist approach to politics, reconceptualizing agency and subjectivity within a broader theory of systems, structures, and historical change.

Bibliography


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